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> "To the solid ground
> Of nature trusts the Mind that builds for aye"—WORDSWORTH

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MACHINERY OF GOVERNMENT

METHODS AND MEN

RECENT criticism of the Civil Service, so far as it is not superficial or biased, is largely an expression of a fundamental concern with the whole machinery of government in Great Britain. That concern has been fed from numerous sources : for example, the examination of our whole organization of production and supply for war purposes, and the related question of the general direction of our war effort ; the difficulties raised by the recommendations of the Scott and of the Uthwatt reports and in attempts to co-ordinate the planning of reconstruction. The statement on a national policy for industry issued by a group of industrialists, following on Mr. S. Courtauld's paper on "Government and Industry" in the *Economic Journal*, stimulates further thought on the mechanism by which the necessary control of industry is to be exercised, a field to which Prof. Cushman's admirable study of the Independent Regulatory Commissions has directed attention in the United States. The report of the President's Committee on Administrative Management is another stimulus to fundamental thinking about the functions and machinery of government which can fairly be compared with the Haldane Committee's report on the Machinery of Government in Great Britain.

The Planning group (P E P) has, of course, addressed itself to the problem, and the fundamental issues were well stated in the broadsheet issued in July 1941, though that was limited to the Civil Service itself. So far as the Civil Service is concerned, there are two fundamental aspects to be considered—methods and men. First, are the methods in use in the Civil Service to-day adapted to handle the new and wider range of problems with which it is called upon to deal in the service of a new and more positive conception of government ? Secondly, is its personnel, by recruitment, training and tradition, competent to handle those questions constructively, imaginatively and efficiently ? A committee of Ministers and an inter-departmental committee of permanent heads of departments is understood to be at work considering, *inter alia*, the machinery of government. The men who are in charge of departments, with all the prejudices and interests as well as the duties of their office, are so clearly the wrong men to conduct such a survey at the height of their war-time activity that far less value is likely to be attached to their findings than to those of the Sub-Committee on the Reform of the Civil Service appointed by the Industrial and Social Reconstruction Committee of the Liberal Party, or of the Sixteenth Report from the Select Committee on National Expenditure, which deals with the organization and control of the Civil Service.

The Sub-Committee presenting the former report had as its terms of reference : "to consider Civil Service Reform in relation particularly to the allegation that the Civil Service as at present constituted has proved wanting in the powers of rapid decision and action". It gives a glance at the question as to what machinery more suitable than the Civil Service can be found, where in the interests of the community as a whole it is necessary to remove particular industries or undertakings from private profit-making to public ownership or control, but the major part of the report is concerned with the reforms required in the pre-war Civil Service to modernize it and bring it more into line with the modern art of administration. That is also the main theme of the Select Committee's report, which, however, passes over the question of administration of nationalized industry, but includes a survey of the functioning of the Central (Technical and Scientific) Register and the General Appointments Register of the Ministry of Labour and National Service and a review of professional and technical staffs in Government Departments.

The Sub-Committee of the Liberal Party opens its report with a review of the pre-war Civil Service and, as in other recent reviews of this matter, tribute is paid to the excellence of the Civil Service for the purpose for which it was originally designed. That much has never been in dispute. The difficulties arise from the fact that it was not contemplated when the Service was created that it would ever be called on to engage in trade directly, to control in detail the processes and operations of commerce, or be responsible for social services and direct contact with individual services. It was instituted to serve fundamentally a negative conception of Government, and the characteristic defects which it has tended to develop have to some extent rendered it inherently unfitted to serve the more positive conception of government to-day.

While this is true, it must also be remembered that its defects are minor compared with the virtues of its freedom from corruptibility and its devotion to the State, as opposed to party or personal interests, and they are also due not so much to the Service itself as to what public opinion insists upon in connexion with it. The policy of safety first is a direct result of insisting that every action of every Civil servant at every hour of the day shall be open to challenge. Furthermore, the Civil Service to-day is the product of Governments which in recent years have been characterized by an unparalleled timidity, vacillation and lack of vision. This inevitably accentuated the bias of the Service to expose the weaknesses, risks and disadvantages of new proposals, rather than to seize what was good in new ideas and embody them enthusiastically in speedy and decisive action.

The tendency to refer to higher authority by minute, and of higher authority to evade or postpone the issue or to consult other authorities before coming to a decision, is thus inherent in the system of Parliamentary questions. Accordingly, among its important recommendations to speed up and modernize the service, the Committee suggests in regard to this first point, while upholding the principle of Parliamentary questions, that reform might proceed through a recognition both in Parliament and in the Civil Service that modern government is too complex a subject for the simple device of the Parliamentary question to be equally applicable to all aspects of it.

Whether or not new mechanism is required to make ministerial responsibility effective without impairing the efficiency of the administrative machine, it is essential to maintain that responsibility. Some of the criticism of the system of public utility corporations has been on this very point of nebulous ministerial responsibility, although it is admitted that the system has to a large extent withdrawn the staffs from the constant stream of Parliamentary criticism. Until such fundamental issues are resolved, however, mere reforms in the method of recruitment of the Civil Service, in training and grading or in operating methods are unlikely to secure a keen and vital Service characterized not only by integrity and the capacity to take a wide view, but also by initiative and the readiness to accept responsibility.

In regard to recruitment, the Liberal Party's Sub-Committee recommends that the practice of grading entrants to the Service by their method of entry should cease and that there should be a system of post-entry training. Engineers and other professional specialists should no longer be regarded as inferior in status to administrative officers and should be remunerated on a scale sufficient to attract officers able to meet on an equal footing the leaders of their respective professions outside. They should be regarded as available for administrative posts. In the senior grades, there should be much more emphasis on systematic interviewing, and provision for an adequate inflow of officers from the lower grades.

With this insistence on a complete ladder from the bottom to the top, the Sub-Committee stresses the importance of post-entry training. The absence in it of a centrally prescribed scheme of training for officers after their entry is a fundamental weakness of the present Civil Service—though a like criticism might equally be advanced of much of the industrial organization of Great Britain. The Sub-Committee recommends the institution of such central courses of instruction by the Civil Service Commission, as well as of departmental courses, and it advocates strongly the establishment of a staff college for the Civil Service analogous to the staff college for the Army, through which those officers likely to be the future holders of the highest posts in the Service should pass. The Committee, moreover, is unanimous that if such a college for teaching, in effect, the art and science of administration were established for industry and commerce generally, it would be even better that the selected Civil Service officers should pass through it than through one established for the Civil Service only. This proposal should meet Sir Warren Fisher's objection that a staff college would accentuate the academic character of the Service. Contact in this way with the future leaders of commerce and industry should facilitate a better understanding of the needs and outlook of commerce and industry and check the narrow professional outlook sometimes attributed to the present Civil Service.

This proposal for a staff college, already advanced by P E P in its broadsheet, is reiterated by the Select Committee on National Expenditure, which makes the same point as to the importance of actual contact in this way of the Civil Servant with commerce and industry and with the work of local authorities, public utility companies, social services, etc., and in particular with those levels of government activity at which Departments come into direct touch with the life of the community, such as the Inland Revenue and Public Assistance. The training thus provided should be of special value in helping to meet the increasing demand for promotion to the administrative grade of selected members of the executive and clerical grades. The Select Committee considers that, subject to tests of character, ability and merit, opportunities of graduating to positions of authority should be open to those who qualify from the school of experience in the Civil Service, equally with those whose qualifications are mainly academic. Moreover, it stresses the value of such a project in providing the training and opportunities needed by Civil Servants who wish to specialize in organization and methods of work.

Beyond this recommendation, the Liberal Party's Sub-Committee contemplates a complete reorganization of the Civil Service Commissioners and wide extension of their powers. It endorses emphatically the recommendation of the Planning broadsheet regarding the divorce from finance of the management and control of personnel. This is regarded as a central function, which cannot properly be discharged by any special department such as the Treasury, and it recommends that the present Civil Service Commissioner's Department should be made into a true central department by removing it from the control of the Treasury, and making it directly responsible to a Minister without Portfolio, who should be the Deputy Prime Minister. The present Establishment Branch of the Treasury would be transferred to the re-organized department, which would be staffed as soon as practicable with officers trained in the modern technique of management. Much importance is attached to method of selection and term of tenure of office of the permanent head of the re-organized Commission. This appointment should be made from within or without the Service by the Prime Minister on the advice of the Minister immediately responsible, and of an advisory committee independent of the Service, and tenure of the office should not exceed five years. As in the report of the Planning group, the importance of eliminating unsuitable officers at any stage in their career is emphasized, while caution is advised in regard to the introduction of outside blood in the more senior grades, on account of the dangers of political pressure and nepotism.

If the Liberal Party's Sub-Committee has relatively little to say about welfare work and office planning, though their importance is noted, the latter in particular is a main theme of the Select Committee's report, which is very largely a review of the whole work of the Organization and Methods Division and the re-organization of the Treasury in regard to the control of the Civil Service. It points out that, following the recommendations of the Haldane and Bradbury Committees, an Establishment Department was erected within the Treasury and establishment officers appointed in most Departments of State throughout the period 1919–39; nevertheless there was no overt sign that the Treasury or the departments accepted the proposition that the organization of administrative machinery was a subject requiring expert and specialized study, or that any lessons in the art of management could be learned from industry and commerce either in Great Britain or abroad. As a result of this twenty years of neglect, the outbreak of war found the Treasury insufficiently equipped to deal with the problems of administrative organization which were forced upon it. There was no core of expert knowledge which might have been built up if the systematic and periodical overhaul of the whole of the machinery of government had been undertaken. Such a body of knowledge might at least have supplied standards by which proposals concerning the staffing of new and expanding departments could have been examined and tested.

The Select Committee considers that control of establishment matters should continue to be exercised from the Treasury for three reasons. First, risk of duplication and waste through the interposition of a new authority between departments and the Treasury, because the Treasury's control on expenditure would still remain. Secondly, it is convinced that the advantages arising from the central position of the Treasury, with its unique knowledge of the general activities of Government, should be retained and utilized. Thirdly, it considers that the view that the association of the functions of finance and supply with those of establishment is bound to be detrimental to the interests of the latter is ill-founded. It bases its recommendations on a conception of economy which is identical with the promotion of efficiency. The ideal control of the Civil Service must be regarded as concerned with the systematic study of the means and methods by which the work of government may be carried out with the maximum efficiency and the minimum waste of time and money. Recommendations are accordingly made for improving the organization of the Treasury.

It is not necessary to accept without question the Select Committee's argument for the retention of Treasury control in order to appreciate the lucidity and precision with which the essentials of the problem are laid bare. The value of that analysis is unaffected whether the ultimate decision is to retain Treasury control or to establish a new central department, as suggested in the report of the Liberal Party's Sub-Committee and elsewhere. The Select Committee's own opinion, however, that, so far as the Treasury was concerned, the period from 1919 until 1939 was marked by an almost complete failure to foster the systematic study of organization as applied to Government departments is possibly the strongest argument against its own recommendation. The re-organization suggested cannot wisely be left in the hands of the same men or in those of similar outlook.

Fundamentally, the problem is one of men and not merely of methods. In any event, either plan of reform might prove equally effective, given men of the requisite imagination, personality and ability. The effectiveness of a staff college, for example, depends on the type of men who teach there, and the vital purpose by which it is informed, and there is no *a priori* reason why a Treasury Department, staffed by men of the right outlook and understanding, should not prove brilliantly successful in securing that the machinery of government is maintained at the highest efficiency and adapted continuously to the purpose to be served. Sir Warren Fisher is unquestionably right in stressing the importance of the problem of the selection of men. As the Select Committee points out, however, expert knowledge of organization is not a monopoly of business men, and it does not regard the commercial world as even the principal source from which efficient organization officers should be recruited. There is a considerable field of recruitment among existing Civil Servants, many of whom possess the vigorous personality and the profound conviction that the study of organization and methods is worth while.

In the long run, however, the spirit and efficiency of the Civil Service are a reflection of the temper and interest of the community it serves. No matter what machinery we devise, we cannot expect a Civil Service of the highest ability and integrity, imbued with vision, initiative and enthusiasm, unless there is mutual understanding and respect between the Service and the community whose interests it serves and safeguards. The biased and irresponsible attacks on the Service by those seeking to promote their own selfish interests under the cloak of a return to the old intolerable muddle of *laisser-faire* do disservice to the State as well as to the Civil Service. It is a great merit of this sixteenth report of the Select Committee on National Expenditure—a report which may well take its place as a great State paper alongside the Haldane Report on the Machinery of Government for its creative analysis—that it provides not only a critical appreciation of the Service, for which Civil servants themselves should be grateful, but also an interpretation of the Service which should promote good understanding and closer and more fruitful co-operation between Whitehall and the public. Here is indeed trenchant criticism and the searching exposure of weaknesses. Here, too, is generous appreciation of good qualities, and an attempt to hold the balance and apportionate blame or responsibility fairly.

No one who attempts to think constructively and creatively about the exceedingly complex problems of modern government, the machinery to be called into being to serve the purposes of the War or of reconstruction in the new order to follow, can disregard this report and its elucidation of some of the fundamental issues upon which our machinery and our philosophy of government must be based. The wide interest in the larger questions of the general control and organization of the Service and the construction of further machinery to increase its efficiency displayed in the recent House of Lords debate, where Lord Hankey lent the weight of his authority to propositions substantially the same as the recommendations of the Select Committee, is one of the happiest indications that we are applying ourselves to a task which will tax the best ingenuity as well as the utmost intellectual resources of either British or American democracy, and in which each democracy may well contribute much towards the solution of the other's particular problems.

A GREAT ETHNOLOGIST

Haddon, the Head Hunter

A Short Sketch of the Life of A. C. Haddon. By A. Hingston Quiggin. Pp. xii + 169 + 7 plates. (Cambridge: At the University Press, 1942.) 7*s*. 6*d*. net.

Born in 1855, A. C. Haddon died at the age of eighty-five in 1940. He richly deserves this exquisitely written life-history. For he achieved a great work and he was endowed with a unique personality. In the selection of her abundant material, Mrs. Quiggin is to be congratulated on her wise judgment. She knew Haddon intimately from the year 1904 when she began to help him, not only in secretarial work, but also in "the concocting of syllabuses and lecture notes, the abstracting of papers, the making of lantern slides and the writing of minor reviews".

Her sketch of his life is not overwhelmed, as so many biographies are, by excessively long extracts from correspondence. She throws much light on his ancestry and early life, which will be welcomed to-day by those who only knew him in middle-age and later. He was descended from three generations of John Haddons, all most ardent Nonconformists, the first a gentleman-farmer of Naseby, the second who founded in 1814 the printing firm of John Haddon & Co. in London, and the third who, failing to inherit the business abilities of his father, allowed the prosperity of the firm to suffer until he was supplanted in 1888 by an abler cousin. The thus dwindling fortune of A. C. Haddon's parents caused frequent family removals from suburb to suburb. It was his fate to be sent to "any school which happened to be in the neighbourhood", and he thus received but a scrappy and desultory formal education. When quite a child, he showed his first interest in acquiring skulls. By then he had already begun to collect minerals, plants, butterflies, eggs, etc., and soon he became busy with dissection and microscopy. At the age of fifteen, he entered the family printing office, where he served five years of "duty and drudgery", hating the work, until his father fortunately came to realize that it would be more economical to send his son to Cambridge, as he would never make a business man of him.

At Cambridge Haddon came under the influence of Michael Foster, McKenny Hughes, Alfred Newton and especially of Frank Balfour, "his beloved master and friend", as he styled him, in a subsequent dedication of his first book, an "Introduction to the Study of Embryology". From his childhood he had shown a fondness for sketching; and while at Cambridge he attended the lectures on art of the Slade professor, Sidney Colvin. This early interest in design was to receive later development in an unexpected scientific direction. He met at Cambridge Holland Rose, a fellow undergraduate, later the distinguished Napoleonic historian, who married Haddon's younger sister. Haddon was appointed professor of zoology in the Royal College of Science, Dublin, in 1880; and a year later he married Rose's sister, whose devotion as mother and wife, self-sacrifice and courage throughout her husband's many hardships and disappointments made her a perfect helpmate.

At Dublin, Haddon felt himself soon "perishing for want of research". He became more and more dissatisfied at having to lecture on coral reefs and tropical fauna which he had never seen. So, in 1888, on T. H. Huxley's advice (who had already visited this region in the voyage of the *Rattlesnake*), he spent a year in the Torres Straits. He went out as a zoologist; he returned as an ethnologist, destined to conduct, eleven years later, that second expedition to the Torres Straits, which earned him such well-deserved fame.

From 1893 he made his home at Cambridge, although retaining his zoological professorship in Dublin until 1901 in order to 'keep the wolf from the door'. His energy, both physical and mental, was throughout his life extraordinary. At Cambridge he at once began to teach physical anthropology, although he received no university stipend and held no university post. His first lectures and practical courses were offered to candidates for the second part of the Natural Sciences Tripos in human anatomy and physiology. I attended the first course in 1893–4, and well recall the care with which his lectures had been prepared and the wonderful skill and enthusiasm he displayed in teaching. Mrs. Quiggin is well justified in her observation: "It may be that his work as a teacher was even greater than his work as a scientist, for he had the gift of inspiring others, and his students have carried his ideals with them to the ends of the earth". The effect, at all events, upon me of my attendance at Haddon's first classes in anthropology at Cambridge was that I became immediately (before taking my degree) engaged on craniometric research, reporting on a collection of ancient British skulls recently acquired by the Anatomical Museum.

In my opinion, Haddon's most natural bent towards the science of ethnology lay in the direction of the study of native arts and crafts—technology. His fundamental contribution to this subject appeared in 1895 when he published "Evolution in Art", which became, as his biographer says, "an unexpected best-seller". He vainly hoped to issue it later in a revised form, embodying much of the immense material afterwards collected. His later works on the stone clubs of British New Guinea, the canoes of Oceania, the decorative art and fabrics of the Sea Dayaks, etc., arouse an intense, righteous anger, because one so eminently fitted to devote himself to this important aspect of ethnology should have felt compelled to spend his time unduly in writing newspaper articles and reviews, in acting as referee to various publishing firms, and in giving lectures throughout the country, in order to 'make ends meet' financially with his growing family of a son and two daughters. Whether or not they persisted sometimes needlessly as a habit, these activities certainly helped to arouse general interest in so young a subject; and anthropology would not have been what it was when Haddon left it had he not felt forced to give so much of his time to its popular nurture.

That he was a successful organizer is patent to anyone familiar with the success of his *chef-d'œuvre*, the Cambridge Anthropological Expedition to the Torres Straits and Sarawak, most of all to one who, like myself, was a member—now the last surviving member—of it. From start to finish of the Expedition and of its work, not a cross word escaped him; what he wanted was done because, under his inspiring and enthusiastic leadership, everyone realized the justice of it. From this expedition he returned in 1899 to find that a successor had been installed in his place, holding the £50 lectureship in physical anthropology which had been created for him in 1895. In the following year he received, in compensation, an appointment to an equally generous lectureship in ethnology at his old University, which only in 1909 raised it to a readership with a stipend of £200. By this time he had been elected to a fellowship at his old college, Christ's, and had been tempted to accept another distraction, the Martin White lectureship in ethnology in the University of London.

His tardy recognition at Cambridge may have been partly due to his unusual personality. "You must be a little mad," he once said, "to get anywhere. You can't advance without overbalancing." "He had no society manners, and his blunt, downright outspokenness was often disconcerting in conventional circles." He rather enjoyed shocking the 'unco' guid' and the prudish; "those whom he thought insincere or silly often thought him rude". Quite wrongly he was often regarded as being merely pagan or agnostic. But behind lay a strong inherited vein of religiousness, philanthropy and generosity. There was indeed some basis for the verdict of one of his (Christianized) Murray Islanders in the Torres Straits, who described him as being "close up alongside God". He had a wonderful love of humanity and a gift of sympathy with, and understanding of, less cultured people, which made him a unique ethnologist in the field. C. S. MYERS.

COLLOID SCIENCE

Advances in Colloid Science

Edited by Dr. Elmer O. Kraemer, in collaboration with Prof. Floyd E. Bartell and Dr. S. S. Kistler. Vol. 1. Pp. xii+434. (New York: Interscience Publishers, Inc.; London: The Imperial Book Co. Ltd., 1942.) 33*s*.

COLLOID science nowadays covers a multitude of the branches of physical chemistry and even of technology. The diversity of subjects treated in the present volume is as wide as the all-embracing title might lead one to suppose. The editorial viewpoint is that the series shall present recent work in this subject by authors who have made significant contributions. If we may judge from the variety of topics dealt with in the first volume there will be no lack of subject matter for some time to come. One consequence of the editorial policy will be that the articles will often contain the individual opinions of the authors and that they will be more in the nature of progress reports than chapters in a text-book. But this fortunately leads to a more stimulating treatment, provided the reader has already some knowledge of the subject under review.

An ever-recurrent problem in technology is the development of a rapid method of determining the state of subdivision of a powder. Usually all that is required is a measurement of the specific surface or perhaps a mean value for the radius of the constituent particles. Microscopic methods are too laborious, and sampling is difficult. P. H. Emmett gives a review of his own work in which the proper interpretation of the adsorption isotherm of selected gases or vapours provides the basis for computing the specific surfaces of the adsorbent. Provided the particles of adsorbent do not have a porous structure a measure of the mean diameter may thus be obtained. Another method of measuring specific surface consists in determining the resistance to the flow of fluid through a plug of powder. Again the technique is not easy, but R. R. Sullivan and K. L. Hertel carefully point out the limitations of the method as compared with existing alternatives. These articles fortunately contain sufficient experimental detail to render them useful as working guides in the laboratory.

Differential adsorption has been brought to a high state of perfection in chromatographic analysis. But there is nothing in principle to prevent the method being more universally utilized, and A. Tiselius describes the modification of the technique for dealing with colourless solutions. The analysis, by refraction, of the concentration gradients of the emergent solution enables the several solutes to be separated and recognized. The method was specially developed for amino-acids and peptides; its success here is proof of its sensitiveness and powers of discrimination.

The mechanism of detergent action, discussed by J. W. McBain, is of increasing importance in many technical processes. There is still much to be done to the theory because the search for new detergents is almost wholly empirical in character. The particular aspect of detergent action discussed is the increase in solubility of hydrophobic substances in water brought about by the addition of these agents.

High polymers rightly assume their proper place in colloid science and consequently in this volume. K. H. Meyer discusses in some detail the structure of starch and shows how purely chemical methods have thrown a flood of light on the way in which the glucose units make up the relatively complex molecule. At the other extreme R. E. Powell and H. Eyring survey the possible application of statistical methods to the physical behaviour of high polymers and their solutions. Owing to the complicated nature of the subject only broad generalizations may at present be formulated. Perhaps one of the more interesting is the conclusion that, in the flow of molecules in the molten polymer, segments of 20–25 carbon atoms move as a whole, which movement is independent of the chain-length of the polymer. Much can be learned of the shape of dissolved or dispersed particles by examining the streaming birefringence of their solutions. Again, enough is given of the technique and of the theory to make this article by J. T. Edsall a good starting-off point for those interested in studying the subject further.

A good indication of recent advances in colloid chemistry in the classical sense of the term is furnished by the elucidation of the structure of the gels of metallic hydroxides by following the process of their formation by examination of their X-ray diffraction patterns. H. B. Weiser and W. D. Milligan thereby add another chapter to the investigation of inorganic colloids. Some of the principles of the coagulation of colloidal solutions now find direct practical application to the concentration and precipitation of rubber from latex. G. E. van Gils and G. M. Kraay describe a systematic investigation of those factors which govern the preparation of concentrated and stable rubber latex which now has—or perhaps had—so many important applications in industry.

E. A. Hauser brings forward his pendent drop method for the measurement of surface tension and further discusses rather too briefly some of the anomalies of the surface tensions of solutions.

The removal of ions from natural water is of fundamental importance in the supply of suitable water to boilers, for the efficient utilization of detergents and indeed for most industrial processes (R. J. Myers). Cations are perhaps the most troublesome, and the base exchange zeolites—natural or artificial—provide one of the best methods of coping with this problem. Zeolites are not, however, unique in this respect, since certain phenol formaldehyde resins contain a sufficient percentage of hydroxy groups to react in a manner similar to that of the zeolites. Progressing a stage further, acid-exchange resins from aniline and formaldehyde allow of the removal of anions and their replacement by hydrogen ion. There is thus theoretically the possibility of removing both anions and cations from water by a two-stage process—in fact, it now is a commercial proposition for the preparation of 'ion-free' water.

It appears to be a far cry from colloid science to electron optics, but the fact is that the electron microscope bids fair to become a useful tool for the investigation of disperse matter lying in the range 0·01–10 μ. T. F. Anderson gives enough in his article to whet the appetite for more and to convince the colloid chemist that an electron microscope is even more useful than the ultramicroscope of classical colloid chemistry.

H. W. MELVILLE.

MUSEUM PRESENTATION OF GEOLOGY

Geology in the Museum

By Dr. F. J. North, C. F. Davidson and Lieut. W. E. Swinton. (Published for the Museums Association.) Pp. viii + 104 + 6 plates. (London: Oxford University Press, 1941.) 5s. net.

POST-WAR reconstruction promises to extend to museums, demanding from them not only rehabilitation after the neglect of the war years but also extended activities along both recreational and educational lines. Aims must be re-examined, collections overhauled or replaced, and exhibitions devised anew. Museum officials, amply supplied with textbooks on systematics, have hitherto been forced to delve laboriously in professional journals in search of papers on museum problems of preservation and presentation. For their especial needs, the Museums Association is publishing a series of handbooks, and that under notice surveys geology in the museum.

Dr. North deals with the general problems of the introduction of geology to a varied public; Dr. Davidson contributes a section on mineralogy; and Dr. Swinton completes the trilogy with one on palæontology. Notes on what to collect are followed by others on treatment and preservation, on registration and storage. The exhibition aspect of geology is prefixed by a discussion of aims, of what to show and how to show it, together with a consideration of layout and labelling, of diagrams, models and other adjuncts. Details of materials and instruments, recommended by past experience for future use, and the sources from which they can be obtained are given in text and footnote. Consideration is given to furniture and equipment, both for exhibition gallery and for staff laboratory. The bibliographies are carefully selected and up-to-date. While this little volume cannot make a curator a geologist, it will help to make a geologist a curator. D. A. A.

EVOLUTION IN ASTRONOMY*

By SIR JAMES JEANS, O.M., F.R.S.

ONE of the most important, and also one of the most fascinating, of the problems of astronomy is the tracing out of the steps by which the universe has evolved from primitive beginnings to its present complex form. But until recently it was like trying to piece together a jig-saw puzzle from which some of the more important pieces were missing. Happily the situation has changed rapidly of late; more pieces of the puzzle have come to light, and one in particular—a better knowledge of the possible sources of stellar energy—is found to fit very convincingly into a big vacant gap, with the result that the whole picture begins to assume a logical and satisfying shape.

Most cosmogonies have assumed that the universe began in a state of complete chaos. Newton saw that a mass of chaotic matter spread uniformly through space would form into condensations under its own gravitational forces, and that these would ultimately divide into separate detached masses. He here indicated the first broad lines of cosmic evolution; we are now able to fill in many of the details.

Astronomers have recently made two complementary discoveries which fit together very satisfactorily —that our galactic system of stars is smaller in size than used to be thought, and that the extra-galactic nebulæ are larger. Obscuring matter spread through space dims the brightness of the stars, making them appear more distant than they are; the recognition of this has brought the distant stars nearer and the galactic system has shrunk. Simultaneously, photometric studies of the sky have shown that the extra-galactic nebulæ extend much farther than appears on the photographs from which we used to estimate their dimensions. It is now clear that the galactic system and the extra-galactic nebulæ are all about the same size, their longest diameters perhaps averaging 100,000 light-years.

Their masses also are found to be not very dissimilar. The mass of the galactic system can be determined from the gravitational pull it exerts on the sun and the stars in its proximity; it proves to be rather more than 100,000 million times the mass of the sun. The masses of the extra-galactic nebulæ can be estimated from the gravitational pulls they exert on one another or on other moving objects; estimates of nebular masses range from 20,000 million to 200,000 million suns.

In this way the galactic system and the extra-galactic nebulæ prove to be similar objects, which we may conveniently describe as 'galaxies'. They are scattered fairly uniformly through space at an average distance apart of perhaps a million light-years. If we assume their average mass to be 100,000 million suns, the average density of matter in space is $2 \cdot 4 \times 10^{-28}$, which gives 200 atoms of hydrogen, or one of mercury, to the cubic metre. If the universe is really expanding in the way suggested by the spectra of the nebulæ, this density is continually decreasing, its value being halved every 450 million years. But the density of the primeval chaos must have been at least of the order just mentioned. With this density adjacent molecules are about a foot apart, while the free-path must be measured in light-years.

If we know the density of a distribution of chaotic matter, and the average speed of the thermal motion of its units, we can calculate the average mass of the condensations which will form in it. Newton conjectured that these condensations would be of stellar mass; we now know they would be of galactic mass. Condensations having an average mass of 100,000 million suns would result from a density of $2 \cdot 4 \times 10^{-28}$ and a thermal velocity of 37 km. a second. The thermal velocity might easily have this high value if the chaos contained a good proportion of free electrons, since these have a speed of 111 km. a second at 0° C.

Thus the first step in the evolution of the universe was probably the breaking up of a primeval chaos into the separate masses which now form the galaxies. These are all of the shapes which would be assumed by compressible masses in rotation, and rotation can be observed spectroscopically in the nearer nebulæ. We do not know how it originated—possibly from currents and swirls in the primeval chaos. In any event, as the condensations contracted under their own gravitation, their speeds of rotation would increase and they would assume in turn the shapes appropriate to different rates of rotation. In the last stage of all, matter lies spread out in the equatorial plane of the rotating mass, where it again becomes liable to gravitational break up, and will form detached condensations. On inserting reasonable values for the density and thermal velocity of this matter, we find that the condensations will be of stellar mass. Thus, except for the intermediate step of the formation of galaxies, we can picture the stars as having been formed much as Newton imagined. As the average density of the parent nebula would scarcely be greater than 10^{-22}, the new-born stars will be of very low density; they will perhaps exist as distinct and detached masses while their densities are still as low as 10^{-20}.

They will of course begin by contracting rapidly under their own gravitation; a mathematical theorem of Poincaré helps us to follow their progress. It tells us that the total thermal energy imprisoned in a gaseous star at any time is just equal to the total energy which the star has lost, or would have lost, in contracting from a state of infinite diffusion. Incidentally, we notice that the more a gaseous star loses energy, the hotter it becomes—not the cooler, as we might be tempted to think.

Thus when the size and composition of a star is known, we can calculate its total thermal energy, and so deduce the temperature of its interior. It is found that the average temperature of the sun's interior must be about 20,000,000°, unless the sun contains a large amount of hydrogen, in which case it will be substantially lower. When other stars are treated in the same way, the surprising result emerges that for the largest class of known stars—the 'main-sequence' stars—the average internal temperature must be exactly or very nearly the same as for the sun.

The total energy supplied by gravitational contraction can, as is well known, only provide a small fraction of the total energy which the sun must have radiated even in geological times, and it has for some time been suspected that the sun—and of course the other main-sequence stars also—must draw energy from some source which comes into operation as soon as stellar matter attains a temperature of the order of 20,000,000°. The recent intensive study of nuclear physics has revealed just such a source of energy.

In a famous series of experiments, Rutherford showed that the nuclei of the atoms of the light elements can be transmuted into nuclei which are chemically different through bombardment by α-particles. Now at the high temperatures of stellar interiors, α-particles, which are merely helium nuclei, are a normal constituent of stellar matter, the helium atoms being broken up into their constituent particles by the heat. The stars become alchemical laboratories, in which the chemical elements continually suffer transmutation as their atoms or nuclei are bombarded by α-particles and other swiftly moving projectiles—protons, neutrons, deuterons, and the like.

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* Substance of a course of lectures delivered at the Royal Institution on November 3, 10 and 17.

Reactions of this type are called thermonuclear. They are mostly very sensitive to changes of temperature, so that each reaction may be associated with a definite critical temperature; below this temperature the reaction occurs only in minute amounts, but above it in torrential amounts. This critical temperature depends very much on the complexity of the nuclei involved in the reaction, being approximately proportional to the square of the atomic numbers of these nuclei. It is consequently lowest—less than 1,000,000°—for the simple reaction of one proton with another. In this reaction a deuteron is formed, and as this leaves an excess of positive electricity, a positron is set free. The deuteron may afterwards capture two more protons and form a helium nucleus.

Next, at temperatures of from 3 to 7 million degrees, protons may react with the nuclei of the light elements lithium, beryllium and boron.

Then, at temperatures of the order of 20,000,000°, comes the reaction of a proton with a carbon nucleus of mass 12. The combination forms a nitrogen nucleus of mass 13, but this is only the first of a series of processes. The nitrogen nucleus may capture a second proton, becoming an ordinary nitrogen nucleus of mass 14, and then a third proton, becoming a nitrogen nucleus of mass 15. This may capture yet a fourth proton, but the result is not a nitrogen nucleus of mass 16; it is usually a carbon nucleus of mass 12, together with a helium nucleus, or α-particle, of mass 4. Actually this description has omitted subsidiary processes which do not affect the final result. The main events consist of the carbon nucleus swallowing four protons in succession, and thereby being pushed along the sequence of nitrogen isotopes until this road comes to an end. It then resumes the form of the carbon nucleus with which it started, the four protons it has swallowed being disgorged in the form of a helium nucleus. In this way four protons are bound together to form a helium nucleus, all the other nuclei emerging unaltered—the carbon has merely acted as a catalyst.

This transmutation may not appear to have any relation to the supply of energy for radiation, until we notice that the total mass of the matter concerned has experienced a diminution. The atomic weight of hydrogen (O = 16) is 1·008, whence the mass of four protons is 4·030, while the mass of the resulting helium nucleus is only 4·003. Thus there has been a loss of mass of 0·027 units, or one part in 150 of the total mass involved.

We know that all radiation has mass associated with it at the fixed rate of 1 gm. for every 9×10^{20} ergs of radiant energy. Thus the sun, radiating $3{\cdot}8 \times 10^{33}$ ergs a second, must lose $4{\cdot}2 \times 10^{12}$ gm. a second—250 million tons a minute. The core of the problem of the source of solar radiation is the finding of mass of this amount inside the sun which is capable of being set free in the form of radiation. Now each thermonuclear reaction in which mass is lost results in an equivalent emission of radiation in the form of γ- or X-rays; these are soon absorbed by the stellar matter and re-emitted as temperature radiation in equilibrium with the stellar matter. Thus thermonuclear processes are fully capable of explaining the sun's radiation qualitatively.

They are also adequate quantitatively. To emit its present stream of radiation for a period of 2,000 million years, the sun must lose one part in 7,500 of its mass; if it consisted wholly of hydrogen (apart from a small amount of carbon acting as a catalyst) it could transform one part in 150 of its mass into radiation by the process just considered. A sun in which only one fifth of one per cent was hydrogen could provide the present sun's radiation for 2,000 million years—and it is fairly certain that the sun contains more hydrogen than this. The evidence of astrophysics is that hydrogen is the most abundant element in most stars.

Other classes of stars present different problems, to which different answers must be given. The most luminous stars of all, apart from freaks, emit about 7,500 times as much radiation per gram of their mass as the sun. Neither thermonuclear reactions nor anything else could enable these stars to radiate at their present rates for 2,000 million years; to do this they would have to transform the whole of their mass into radiation. We must conclude that such stars cannot radiate as at present for another 2,000 million years, and probably have not done so in the past, unless they can draw on external sources of energy, as, for example, by an accretion of matter from outside. The red giants and Cepheid variables, which do not belong to the main sequence, have central temperatures well below the 20,000,000° which characterizes the main sequence stars. The carbon reaction cannot occur in these in appreciable amounts, but it seems likely that reactions with elements lighter than carbon may provide the energy for their radiation. In time, all these light elements will have been used up; the star will then contract, its internal temperature continually increasing, until it reaches 20,000,000°. The star has now joined the main sequence, and the carbon reaction comes into play to supply it with radiation.

Again, the smallest stars have central temperatures well above the critical 20,000,000°. These must have used up all their hydrogen, and then started contracting afresh. The energy they are emitting as radiation may be derived from their gravitational contraction—which could supply radiation for perhaps 100,000 million years—or possibly from some other thermonuclear processes, not yet identified, which occur at temperatures above 20,000,000°.

Certain minor complications, such as have already been mentioned, do not affect the occurrence of the processes, but they ensure the stability of the star. A process in which the generation of energy increases rapidly as the temperature increases is usually unstable. For any slight increase of temperature causes an excess generation of energy, which causes further heat, still more generation of energy, and so on indefinitely; the process becomes explosive. But when, to take a single instance, a carbon nucleus has swallowed its first proton and become a nitrogen nucleus of mass 13, it must emit a positron before it is ready to swallow a second proton. This is emitted by a sort of radioactive disintegration and, as an increase of temperature does not increase the rate of radioactive disintegration, the explosive sequence of events just mentioned does not occur. An increase of temperature will now merely increase the pressure inside the star, so that the star expands and cools. By this thermostatic mechanism, the star continually adjusts itself so that just enough energy is generated to replace that lost by radiation. From its nature the adjustment cannot usually be instantaneous, so it is perhaps not surprising that the stars which are cooler than 'main sequence' stars are mostly variable stars in which regular and substantial fluctuations of light occur.

Thus we think of the matter of the primeval universe as having first condensed to form separate detached masses, one of which ultimately formed our galactic system. This process may well have taken tens of thousands of millions of years. These distinct masses in their turn broke up into separate stars, taking perhaps hundreds of millions of years to do so. These stars would at first be cool, of low density and of immense size. After contracting for a few million years, they attain a temperature at which the proton-proton reaction begins to occur. But at low temperatures this reaction occurs but rarely—too infrequently to make good all the energy lost by radiation. The stars accordingly continue contracting until they attain temperatures at which the protons react to an appreciable extent with the nuclei of light elements. This reaction may supply radiation for a few million years, after which the light elements are used up; then contraction begins afresh and continues until the temperature of 20,000,000° is reached. The carbon reaction now takes control and can supply radiation for thousands of millions of years if the star is not too massive and luminous. During this period, the proton-proton reaction still occurs, and may provide for an appreciable part of the star's radiation—perhaps for half in the sun, and for even more in less massive stars. Finally, the supply of protons gives out, and the star contracts once more—possibly for hundreds of thousands of millions of years.

At some point in this sequence of events the sun has given birth to planets; at some point other stars may do the same. Mathematical investigation shows that planets can be born out of a star by tidal action—through a second star approaching near to it and drawing out a long filament of gas, which then breaks up gravitationally and condenses into separate planets. If the two stars are of similar build, such an event requires an approach to within about three radii, whatever the sizes of the stars may be.

Approaches of the requisite closeness would clearly be far more frequent in the early period when the stars were big, than in the later period when they were compact. For our sun, the first period was short (less than 20 million years), while the latter period has been long (more than 2,000 million years). Nevertheless, calculation shows that an effective tidal encounter is far more likely to have occurred in the former short period than in the latter long period. It is not surprising, then, that the solar system is found to contain intrinsic evidence that its planets were born while the sun was still of immense size. It must have extended an appreciable fraction of the distance to the present orbit of Pluto: otherwise there would have been no mechanism for putting the outermost planets in their present orbits.

It follows from this that the age of the sun as a star is approximately equal to the age of the earth as a planet—probably between two and three thousands of millions of years. In this period, the sun can only have used up a small fraction of its protons, so that it probably can look forward to a life in its present state which will be incomparably longer than the life that lies behind it. When this is over, it will begin to shrink into a smaller and cooler star, and life on earth will become impossible.

Detailed calculations show that the chance that a star shall give birth to planets while it is of the compact dimensions of our sun is quite negligible. On the other hand, the chance of its having given birth to planets before attaining to this state is considerable—a fair proportion of the stars must, then, be accompanied by planets. Of these a substantial fraction are likely to be in a physical state not very different from that of our own earth, and so capable of maintaining life like our terrestrial life; it is possible that such life is far more abundant in space than we used to think.

PREVENTION AND TREATMENT OF ANTI-SOCIAL BEHAVIOUR

IN his Chadwick Lecture on "The Differentiation, Prevention and Treatment of Anti-Social Behaviour Disorders" delivered on December 8, Dr. Norwood East has made a succinct but systematic review of the main established facts regarding the causation of crime, and has presented a convincing argument for the view that crime is as much a scientific as a legal or a medical problem. Dr. East was for many years one of H.M. Commissioners of Prisons, and Medical Inspector of Prisons in England and Wales. He has recently completed a scientific study on an extensive scale of the medical, social and psychological aspects of crime, more particularly among adolescents (see NATURE, September 26, p. 361). He is therefore able to speak both with experience and authority; and much of his lecture is in fact concerned with the practical corollaries to be deduced from the inquiries that he has made.

Generally speaking, Dr. East regards behaviour disorders as manifesting in nearly every case a complex causation. They are "the result of stress, acting upon an inherited constitutional pattern, which may itself have been modified, in varying degrees, by environmental factors other than the stress itself". The inherited constitutional factors are themselves incapable of being greatly changed. It follows that, in general, the treatment of anti-social behaviour must be limited to efforts at changing the environmental factors, and particularly to relieving whatever stress may have precipitated the criminal action. In different cases, however, the relative importance of the constitutional factors, on one hand, and of the environmental factors, on the other, may differ widely. Thus, although individuals belonging to certain temperamental types may be more liable to yield to temptation than persons of average mental heredity, nevertheless, "the majority of persons, and perhaps all, are potential first offenders"; for criminal action, as a rule, results, not from one type of factor to the exclusion of the other, but from "a disturbance of the balance between the two".

According to Dr. East, therefore, the fundamental psychological premise from which the criminologist has to start is the fact that "no person corresponds exactly to his fellows; for even an arbitrarily selected normal person occasionally shows peculiarities of behaviour". Consequently, while anti-social behaviour may be precipitated by almost any form of maladjustment between the individual and his environment, some individuals, by nature or by habit, will be more prone to disregard the requirements of the society in which they live, and so more easily led into actions which that society regards as criminal. This is especially true of those suffering from mental defect or mental disease. Much of his lecture is, therefore, devoted to the relation of crime to these particular pathological conditions.

Among inborn factors, the most important in his view are the inherited "drives", a term which he borrows from American psychologists to denote "the impulsive energy of any instinct". In guiding social behaviour, he holds, the acquisitive, sexual, gregarious and self-preservative instincts prove to be exceptionally powerful; and he argues that "much practical insight into normal and abnormal motivation is gained by regarding the various instincts and their accompanying emotions as the basic essentials of purposive action". But instinct is not all. Intelligence, as the psychologist defines the term, is equally an inborn factor. Differences in innate intelligence may limit the powers of self-control and of learning by experience. Hence individual intelligence has also to be taken into account in considering motive or lack of motive, and in proposing suitable treatment. In particular, as he points out, "it is characteristic of much anti-social behaviour that the desire of the moment, the proximate aim, is more importunate and decisive than a long-term ambition or desire".

Children and adolescents, owing to their immaturity, are largely under the sway of their innate impulses; and, particularly if brought up under adverse home conditions, may be slow in learning to control their conduct by intelligence or experience. Hence, during childhood and puberty, many forms of behaviour may arise as part of the normal development of the growing boy or girl which in an adult would be looked upon as criminal. In discussing the treatment of juvenile delinquents, Dr. East briefly notes the valuable part that may be played by child guidance clinics both in prevention and cure; and is apparently inclined to attribute much of the delinquency that is rife among children at the present day to ignorance of "even elementary standards of conduct". As to the means of combating this ignorance, he cites the view of the Middlesex Education Committee, which urged that "religious education was the surest means of acquiring these standards", and reported that teachers themselves were showing "considerable enthusiasm for this branch of education".

Since criminality is more apt to arise in persons of abnormal mentality, Dr. East, like most medical investigators, has paid special attention to the association of anti-social behaviour with insanity, with mental deficiency, with neuroses, and with psychopathic states; and quotes authoritative figures. "Although no particular crime is characteristic of insanity, the proportion of homicides in this country who are insane is much greater than the proportion of those who commit other offences"; but "criminal conduct associated with insanity may extend almost throughout the whole gamut of crime". The forms of major mental disorder chiefly associated with crime are schizophrenia, manic-depressive disease, and paranoid states; and since in each of these conditions inheritance appears to play an appreciable part, eugenic marriages, he argues, may tend in some degree to diminish the number of offspring liable to develop anti-social behaviour. However, as he goes on to point out, the frequency of definite insanity among criminals is exceedingly small: the number of persons received into prison who are either insane on reception or become insane during detention is barely 1 per cent of the admissions.

Mentally defective criminals are even fewer; they form only half of 1 per cent of the admissions. However, the higher grades of mental deficiency shade off imperceptibly into normality through a subnormal group, who may also display anti-social behaviour. The mentally deficient "commit various crimes including murder at one end of the scale and vagrancy at the other"; but "the majority of their offences are connected with the acquisitive instinct, namely, theft, embezzlement, false pretences and the like; next in frequency are various sexual offences; but, as with insanity, no particular kind of crime is characteristic of the condition". The defective offender, however, very easily forms a criminal habit; and the danger to the community from his misconduct is to be measured, not merely by a particular offence, but by his incorrigibility. Hence the importance in these cases of enforcing early institutional care. A large measure of prevention has already been secured by prompt ascertainment, followed by segregation or supervision; but, it is argued, if eugenic principles could be applied, still more anti-social behaviour would be prevented.

Since psychoneurosis is often precipitated by emotional maladjustment, it is not surprising to find that many criminals show neurotic symptoms. Here precise figures are harder to obtain. Hysteria, Dr. East believes, is far more frequently associated with major forms of anti-social behaviour than is sometimes supposed. Anxiety states, too, may often form the chief cause. On the other hand, contrary to notions prevalent among the general public, obsessive and compulsive states are not often related to serious misconduct; and, apart from the occasional effects of the accompanying hypersensitiveness and irritability, neurasthenia (in the proper sense of the term) is comparatively infrequent as a causative factor. In his investigation of 4,000 adolescent criminals, Dr. East found no more than 48 suffering from definite psychoneurosis—not much more than 1 per cent. In all such cases Dr. East once again stresses the importance of early recognition: the more promptly psychotherapeutic measures are applied, the less likely is anti-social conduct to ensue.

In criminological literature the phrase 'psychopathic personality' often becomes (as Dr. East acknowledges) a kind of waste-paper basket, into which anything that cannot be pigeon-holed under more definite headings may all too easily be bundled together. Nevertheless, he believes that there is a small but well-defined group, including schizoid, cycloid and paranoid personalities, as well as perverts, drug addicts, alcoholists and the mentally unstable generally, to whom the term may be usefully applied. The disabilities and social difficulties of the so-called psychopath seem largely due to innate factors; and the prevention of anti-social disorders among such persons consequently presents a serious practical difficulty. Treatment has often to be restricted to efforts designed merely to modify the particular impulse or activity which is leading the patient into conflict with the law.

On the whole, however, as Dr. East insists, "the majority of prisoners found guilty of criminal offences do not show abnormal characteristics (although, of course, they exhibit individual variations among themselves, just as other groups of persons do). . . . The figures disprove the assertion of those who declare that crime is a disease." Coming from one who, in virtue of his work, his experience, and his writings, is among the foremost authorities on the subject in Great Britain, and is himself a medical man, this is a most significant pronouncement. Both in the medical and in the educational world there are still numerous writers and administrators who do not realize how opinion upon this point has changed. The trouble seems to be that laymen and Government officials are alike inclined to think that the qualified expert in mental science must be the medical man. Psychology, owing doubtless to the publicity given to its more sensational problems, is confused with psychoanalysis, and not yet regarded as a science in its own right. Many of the pioneers who have urged that the prime need of the adult criminal is treatment rather than punishment have done so on entirely misleading grounds, namely, that "crime is a pathological symptom, and therefore the criminal should be accorded the same medical care as any other mental sufferer". Similarly, when child guidance centres were established they were called 'clinics' (as though backward pupils as well as young delinquents were mentally diseased); and it has been the official policy of the Child Guidance Council itself that "since crime is a form of illness, the child guidance clinics at which such cases are examined should be under a medical director". No doubt, in a small proportion of the cases, moral delinquency, like educational backwardness, may be the outcome of physical or mental illness; and in every case the first step is unquestionably to investigate the possibility of such illness as a contributory factor. Recent investigations, however, like those of Dr. East, prove conclusively that it is, as a rule, only a minor factor, and a comparatively rare one at that. Hence, as recent experience has shown, there is considerable danger that exclusive or excessive emphasis on the need for a medical approach may lead to the neglect of other lines of study and treatment that are far more important—the social, the educational, or the psychological.

In all cases of delinquency or crime it is the psychological rather than the physical or pathological characteristics of the individual that call for first consideration. But in early years it is the social and educational environment—the home and the school—that are usually the deciding factors. "The home," says Dr. East, "should be the first training ground." The lad who comes from a broken home or from a family where discipline is unduly harsh, unduly lax, or so erratic as to be virtually non-existent, is not only more liable to drift into vice and crime, but also more resistive to subsequent efforts at reform. A wholesome training in the school is equally essential as a supplement to, and often as the only substitute for, the training in the home. "But its value is not to be measured by its success in teaching a lad how to acquire knowledge or even by its material usefulness in after life : . . . the formation of moral principles and habits is the most important part of education." "For this and other reasons," Dr. East observes, "the criminologist will welcome the proposal to raise the school-leaving age." As regards economic conditions, he finds that the relative amount of unemployment among offenders was not appreciably greater than that obtaining among the general population: but they seemed far more liable to commit their offences during spells of unemployment than at other times. In particular, he urges the importance of vocational guidance as a means of combating delinquency: among adolescents more especially, it would seem. "wrong placements tend to invite anti-social behaviour".

As to punishment, Dr. East notes that "the tradition that imprisonment is solely punitive still persists in certain quarters; but it cannot be too widely known that its modern purpose is treatment and training". This, as he points out, is the attitude taken in the Criminal Justice Bill of 1938, which was before Parliament before the outbreak of the War. That penal measures do not altogether fail is, in his view, borne out by after records: thus "of 17,918 males and 2,749 females who were over the age of 16 years in 1932, and were found guilty in that year of offences sufficiently serious to warrant the taking of finger-prints, and had no previous proved offences recorded against them, 90 per cent of the older males, and over 70 per cent of the younger, were free from any further charges during the subsequent five years : the figures for females were nearly 90 per cent".

Due attention to the psychological study of the criminal must be one of the items that should claim a foremost place in the programme for post-war reconstruction. Since at the moment the urgent need is knowledge, more detailed, more precise, and, in a word, more scientific, about the reactions of the individual mind, one of the first steps should be to establish "an institution where research into the problems of criminal behaviour, and the scientific treatment of offenders, can be carried out". "And the conclusion of the whole matter," says Dr. East, "seems to lie in the fact that a democratic State can no longer afford to ignore the effects of social hazards which are harmful and preventable; the treatment of delinquent and criminal behaviour are not merely matters that concern lawyers, administrators and scientists; they are matters that concern us all."

A PHYSIOLOGICAL THEORY OF COLOUR PERCEPTION

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It is nowadays possible to record the discharge of the retinal elements directly by leading off to electrodes from more or less isolated fibres of the optic nerve. The electrical impulses following upon illumination are the physiological means of communication between the retina and the higher centres. They are amplified and led to an oscillograph for photographic recording and at the same time listened to in a loud-speaker. This is the technique for which the well-known work of Prof. E. D. Adrian and his collaborators originally laid a solid basis. For isolation of the fibres in the optic nerve a method of micro-dissection around the blind spot has been developed by Hartline[1] and a micro-electrode technique for picking up from the fibres inside the eye by Granit and Svaetichin[2]. The latter method is a great deal simpler and faster than the former, and for this reason it is the natural instrument for a rapid survey of the colour properties of a large number of single or grouped units in the response of the eye to illumination with spectral light of known energy

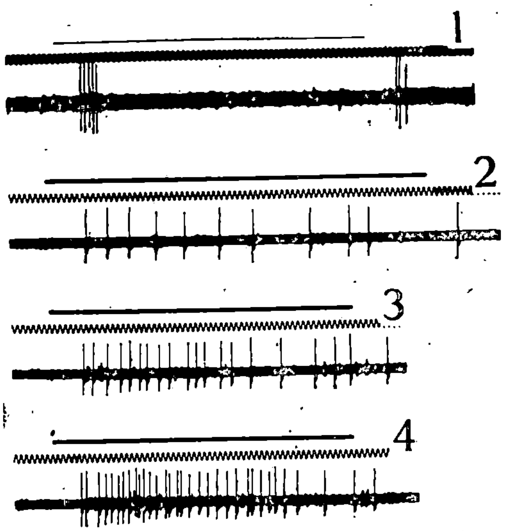

Fig. 1. IMPULSES PICKED UP BY A MICRO-ELECTRODE PLACED ON THE NERVE FIBRES INSIDE THE RETINA. ABOVE EACH OSCILLOGRAM IS THE TIME RECORD (50 PER SEC.) AND LIGHT SIGNAL.

1. "On-off"-element from photopic cat's retina responding to light of wave-length 0·660 μ. Somewhat above threshold.

2–4. "On"-element from scotopic retina of guinea pig responding to "white" light: 2, at strength 0·006 m.c.; 3, at 0·018 m.c.; and 4, at 0·061 m.c. Note increasing frequency and shortening latent period, as stimulus intensity increases.

content. Mammalian eyes can be studied with the micro-electrode as easily as eyes of the cold-blooded animals, to which the technique of micro-dissection is limited if it is to be used for analytical purposes. The animal is anæsthetized, cornea and lens removed, and the micro-electrode inserted with the aid of a micro-manipulator under suitable optical magnification.

Successful isolation, in mammals particularly easy to accomplish, leads to a discharge of spikes of impulses (Fig. 1). In different elements a response follows onset of illumination or both onset and cessation of illumination, as first noted by Hartline[1] with the frog's eye. In the latter and in some other eyes, there are also elements which merely respond to cessation of illumination. But these different types of responses are of less interest in this connexion because of the absence of any definite correlation between type of discharge and type of colour sensitivity, to judge by the work so far carried out.

In order to analyse the colour sensitivity of such discharges, we proceed to measure the amount of energy necessary for eliciting a threshold response in the different wave-lengths of the spectrum. If the element under the electrode has low sensitivity for light of a given wave-length, much energy is needed to elicit a discharge; if it has high sensitivity, little energy is required. Thus the inverse value of the energy necessary for a threshold response in each wave-length is the ordinate (per cent of the maximum) plotted in the curves of Figs. 2 and 3, illustrating the spectral properties of the retinal receptors. I shall briefly direct attention to some results of general interest from work published during 1940–42 (*Acta Physiologica Scandinavica*; preliminary review, *J. Amer. Opt. Soc.*, **31**, 570 (1941)). Since then the number of animals studied has been extended and principles have emerged which in my opinion suggest a relatively simple interpretation of some of the fundamental facts of colour vision, particularly of the differentiation of our sensations into the two categories of brightness (or luminosity) and colour. The principles discovered may also be of practical importance.

Analytically, the simpler structure is the dark-adapted eye with its rods fully charged with visual purple. We are familiar with the absorption curve of this substance. It was first accurately determined, with in every respect satisfactory and up-to-date technique, by the late R. J. Lythgoe[3], of University College, London. Our electro-physiological analysis of eyes of different animals in dark-adaptation has shown that a plot of the inverse value of the energy necessary for a threshold response reproduces the absorption curve for visual purple with perfect fidelity, provided that the curves are corrected for presentation in terms of quantum intensity, a necessity first pointed out by Dartnall and Goodeve[4] in NATURE. The maximum of this absorption curve is around 0·500 μ. Visual purple also determines the luminosity curve of the dark-adapted human eye (scotopic spectrum). After the latter has been light-adapted the maximum of our luminosity curve shifts to the region of 0·560 μ (Purkinje shift) and the new curve obtained determines the distribution of brightness in a spectrum strong enough to elicit sensations of colour (photopic spectrum). As is well known, the retina is then supposed to utilize cones as receptor elements.

In light-adapted eyes of animals the simple spectral sensitivity curves recorded with the micro-electrode technique are of two types: (i) broad absorption bands, here called *dominators*; and (ii) narrow bands, here called *modulators*. The most interesting fact about the photopic dominator, apart from the width of the curve, is the localization of its maximum to the region around 0·560 μ, as shown in Fig. 2 for frog and snake (Tropidonotus); the latter a pure cone eye which need not be light-adapted to give this curve. The same dominator has been found in the eye of the cat. The dominator is lacking in the eyes of guinea pigs and rats. The form and spectral locus of the dominator is practically identical with the average curve obtained from massed receptors in the light-adapted eyes of the same species. In this sense the dominator may be called the carrier of the Purkinje shift. This and its good correspondence with respect to form and locus with the luminosity curve of the light-adapted human eye necessitate the conclusion that the dominator is responsible for

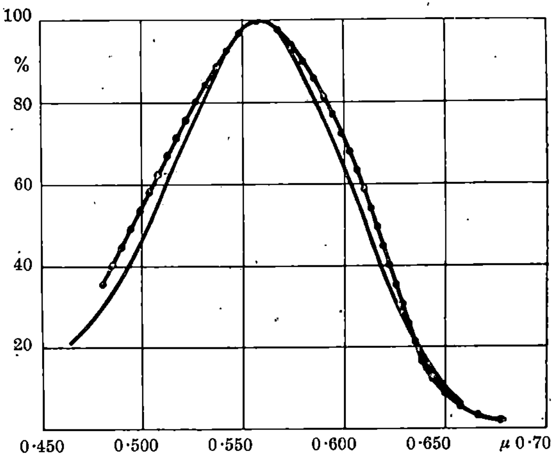

Fig. 2. DISTRIBUTION OF SENSITIVITY OF "DOMINATOR" ELEMENT IN THE RETINA OF FROG (UNINTERRUPTED LINE) AND SNAKE (LINE INTERRUPTED BY DOTS).

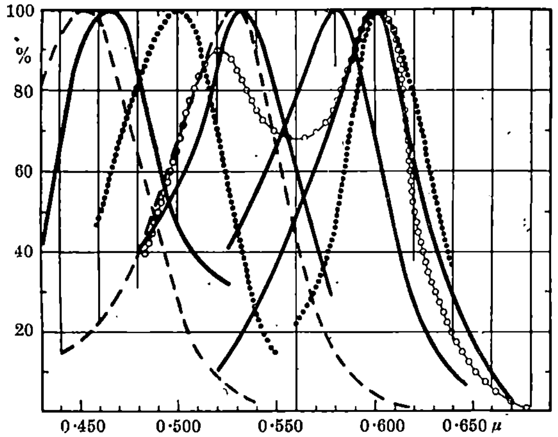

Fig. 3. DISTRIBUTION OF SENSITIVITY OF "MODULATOR" ELEMENTS FROM EYES OF RAT (DOTS), GUINEA PIG (BROKEN LINE), FROG (LINE IN FULL) AND SNAKE (LINE INTERRUPTED BY CIRCLES). NOTE THAT ALL CURVES ARE IN PERCENTAGE OF THE MAXIMUM AND THAT A NUMBER OF ORDINATES ON EITHER SIDE OF 0·560 μ ARE DRAWN DOWN TO INDICATE "DOMINATOR" VALUES. ALL SPECTRA OF EQUAL QUANTUM INTENSITY IN BOTH FIG. 2 AND FIG. 3.

the sensation of brightness, which thus is our dominant impression, coming, as it does, from the dominant receptor, dominant also in the sense that it is the most frequent one.

How then is colour vision possible ? Modulation of the dominant impression of brightness to colour would seem to be the task of the much rarer modulators which occupy very narrow bands of sensitivity in three preferential regions around 0·580–0·600 μ, 0·520–0·540 μ and 0·450–0·470 μ. These are shown in Fig. 3. In addition, there is also in some eyes (rat, guinea pig) a narrow band in the region of 0·500 μ, which is the spectral locus of the maximum of the absorption curve for visual purple. The rat has 1 per cent cones, the guinea pig still less, if any. It is an interesting fact that in these eyes, which lack dominator and Purkinje shift, light-adaptation does not completely remove the absorption curve for visual purple but changes it to a very much narrower curve of modulator type, still placed in the same region. Light-adapted rods in this case serve as cones.

The most regularly recurring modulator in the different species studied has been the 'red' one with maximum at 0·600 μ. It has even been found in the eye of the rat, which lacks the dominator, but not in guinea pigs. In the cone eye of the snake the 'red' modulator was generally, though not always, connected to a 'green' hump at 0·520 μ, which sometimes was more, sometimes less, developed. Its narrowness (see Fig. 3) suggested a 'green' modulator which, however, was never obtained in the isolated state in this animal. But in guinea pigs and frogs 'green' modulators with maxima around 0·530 μ were seen. The 'blue' modulator was first found in the eye of the frog, then in the guinea pig. In both retinæ it is quite common in the shape of a hump on other curves, but it is difficult to isolate. The frog, of all the animals studied, has the most complete set of modulators (cf. Fig. 3). As rods and cones may converge towards a common retinal ganglion cell (Polyak[5]), and as many other factors antagonize isolation, it is clear that all attempts to interpret complex curves as well as to understand the nature of the sensory message as a whole must begin by emphasizing the positive character of the evidence for the existence of curves as simple as the modulators. Complex curves with several humps are, of course, common.

The experiments with the cone-eye of the snake suggested that the dominator itself is composed of modulators joined together in such a fashion—either photochemically or by connexions in the retinal synapses—as to operate as a *functional unit.* However, this assumption, though probable, is not essential to the theory based on the experiments. But it would explain why stimulation of all modulators together also causes an impression of white, and not of all colours confused. The modulators would in this case merely add to the effect of the dominator. Alternatively, the modulators could be coupled in antagonistic pairs which simultaneously neutralized each other at the retinal or some higher level. As a matter of fact, in eyes where both 'red' and 'green' modulators are present, they are very difficult to isolate from each other.

But let us now see what kind of theory of colour vision would be a direct consequence of the experimental subdivision of the receptors into a great number of almost identical dominators and a smaller number of narrow modulators varying somewhat in shape, locus, sensitivity and number within three preferential spectral regions. No further assumptions will be introduced beyond the original one, that the dominator stands for the dominant impression of brightness, and is modulated by the modulators so as to give the higher centres a cue for their integration of 'colour'.

(1) The greater the distance in the spectrum from the centre of the dominator the darker the colour. Colours towards the ends of the visible spectrum must be dark by comparison with those near the top of the dominator. This we know to be true.

(2) W. D. Wright[6] has shown that selective adaptation of the human eye to any colour causes chiefly a large general reduction of brightness and an insignificant selective effect on the fatiguing colour. This also is a direct consequence of a dominator for the perception of brightness. Classical theories would seem to require not only a much larger selective effect on the fatiguing colour but also a considerable shift of the luminosity curve.

(3) As it is improbable that all receptors would be of exactly the same threshold, a diminution of intensity should, on classical theories, lead to perception of coloured spots. Instead we know that it leads to the spectrum becoming colourless, with the brightness distribution of the dominator, as required by the presence of this most common receptor.

(4) Similarly, a reduction of area of the visual object, which is known to lead to disappearance of its colour with maintained brightness distribution, must do so because the 'small' stimulus merely has a chance of hitting upon the common dominators.

(5) Colour-blindness need not, but *can* be possible without parallel change of the photopic luminosity curve. A colour-blindness of this type would be the common form of red-green blindness known as deuteranopia, to be interpreted as absence of the 'red' and 'green' modulators, with the remaining dominator alone giving the normal luminosity curve. Without a separate structure for the perception of brightness as distinct from colour, no theory can ever hope to explain colour-blindness unaccompanied by considerable 'luminosity blindness' to light from the 'blind' region of the spectrum.

Many of the animals studied represent different types of colour-blindness if considered from the point of view of the complete colour sense of man. The guinea pig probably comes very near the totally colour-blind, the cat near the deuteranope. The cat has the typical dominator but no definite 'red' modulator. The guinea pig, however, has a number of different modulators in the short wave-lengths and hence may be able to discriminate colours in this region. But it lacks dominator and Purkinje shift. The totally colour-blind human has a photopic luminosity curve practically identical with the luminosity distribution of the normal dark-adapted eye dominated by visual purple. The guinea pig has the same scotopic *and* photopic sensitivity curve, slightly distorted by a hump in the blue in the photopic state.

With the three preferential regions for the modulators, it is clear that this theory can do what the trichromatic theory does and also that it demonstrates the essential correctness of Thomas Young's great generalization, although it is necessary to assume a greater or lesser number of somewhat different modulators within these regions. The main crux of the trichromatic theory and, indeed, of any classical theory, is the lack of precision in the concepts accounting for the perception of white as a separate entity which, nevertheless, somehow is intimately connected with the perception of colour. The trichromatic theory regards white as due to the summed effects of, chiefly, the 'red' and the 'green' sensitivity curves. This forces the theory to accept the consequence that removal of 'red' and/or 'green' should cause removal of the perception of luminosity in the same region of the spectrum. Hence there can be no colour-blindness without profound changes in the form and locus of the luminosity curve. It is an admission of failure to have to explain so important a phenomenon as deuteranopia by pushing it aside to be taken care of by the 'higher centres'.

Many of the phenomena to which the trichromatic theory has directed attention need not be discussed for the reason that my theory does not necessarily exclude the explanations already available. Thus, for example, the fineness of colour discrimination in different regions of the spectrum may be explained in the classical way, or else by the assumption that the number of slightly different modulators is particularly great in the regions where the maxima of colour discrimination are placed.

In its present form the theory gives no explanation of contrast colour, though certain alternatives seem reasonable in view of the fact that different elements are so often coupled together and that the retina contains a large number of coupling synapses. If a certain percentage of the 'red' and 'green' modulators are coupled together in such a manner that both are forced to discharge when either is stimulated, the natural result to expect from the asymmetry caused by fatiguing either of them is that the other one should predominate in the neighbouring region as well as in the off-effect. The experiments themselves have not yet dealt with situations calculated to bring forth contrast phenomena.

It is impossible in this brief review to deal with the available evidence concerning the nature of the colour-sensitive substances. The hypothesis I prefer is that visual purple—which may be called the dominator of the scotopic eye—is the mother substance for the photopic dominator and the modulators. Its molecule consists of a protein nucleus serving as carrier for about ten chromophoric groups (see Broda, Goodeve and Lythgoe[7]). The different colour sensitive substances may be due to changes in the linkage between carrier and chromophores.

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[1] Hartline, *Amer. J. Physiol.*, 121, 400 (1938).

[2] Granit and Svaetichin, *Upsala Läkaref. Förh.* N.F., 45, 161 (1939).

[3] Lythgoe, *J. Physiol.*, 89, 331 (1937).

[4] Dartnell and Goodeve, NATURE, 139, 409 (1937).

[5] Polyak, *Arch. Ophthalm.*, 15, 477 (1936).

[6] Wright, *Proc. Roy. Soc.*, B, 115, 49 (1934).

[7] Broda, Goodeve and Lythgoe, *J. Physiol.*, 98, 397 (1940).

DARWIN'S HEALTH

By SIR BUCKSTON BROWNE, F.R.C.S.

PERSONAL experiences of great men are always interesting, and often instructive. There has lately come to light a diary of his health by the immortal Charles Robert Darwin, from 1849 until 1854. It is now in the possession of the British Association for the Advancement of Science[1], and the Association's Secretary, Dr. O. J. R. Howarth, has permitted me to read it. It consists of thirty-four pages of unruled foolscap.

There is no doubt that the hardships of his five years voyage on board H.M.S. *Beagle* seriously affected Darwin's health. At first he tried to live in London, but found it impossible, and he sought a home in the country. He found it at Down House, Downe, Kent, sixteen miles from London, well away from any great road, quiet and secluded. He lived there for the rest of his life, forty years, dying in 1882, aged seventy-three. Down House is roomy, there are a large vegetable and fruit garden and considerable meadow land. It had no water or gas supply, and no bathroom. There was a cesspool—and a well. Cows and pigs were kept, the stables were large, and the dairy and coachman's house were separate buildings. There was a long path, called the "Sand-walk", along the northern side of the meadow land.

When Darwin began this daily account of his health, he had been married for ten years; he had a devoted wife, and a comfortable home, but the diary is a record of continual misery and suffering, although often the days are marked "good", and the good is sometimes underlined or even doubly underlined. His nights are disturbed by severe attacks of flatulence. In the daytime he suffers from attacks of sickness and vomiting. He has headaches and dizziness. He mentions lumbago and arthritis, and most painful of all, a succession of attacks of boils. They are allowed to burst of themselves and no antiseptics are used. One boil is described as "very large". He has pyorrhœa and sore gums and a tooth has to be extracted under chloroform. He complains that his writing has become very bad.

While the diary was kept, Darwin visited London, Eastbourne, and Great Malvern, where he tried the water-cure, and in a curtained corner of his study at Down House he kept a large shallow tin bath, and in the diary "douches" and "double douches" are mentioned. At the time a so-called electric belt was much advertised; it was tried and abandoned.

Darwin daily walked in his garden and up and down the "Sand-walk", and rode about the neighbourhood on a stout cob. After early manhood he smoked only occasionally. He became a regular snuff taker, but in order to keep the habit in abeyance kept his snuff jars in the hall, so that when desiring a pinch he had to rise and leave the room.

Darwin's last remaining son, Major Leonard Darwin, R.E., born in 1850, has given me the following particulars of his father's daily meals. He generally breakfasted alone; tea, with sugar, milk or cream, toast and a little bacon. He lunched with his family —joint, vegetables, and a simple sweet pudding. He drank a glass of sherry. He had afternoon tea with Mrs. Darwin. Dinner was a repetition of luncheon, and sherry was again taken. He never took ales or spirits, but often drank tea with his dinner.

Many have found the accounts of Darwin's continued ill-health somewhat mysterious. There cannot have been any organic disease, for he lived to be seventy-three, and all seems clear now—he was the victim of chronic indigestion, induced by five years of hardship at sea, with scant accommodation on a small ship and with roughly prepared food. All this would permanently upset the digestive organs of a highly sensitive man.

Indigestion results from: (1) imperfect mastication; (2) too much food; (3) improper foods. I think the cold baths must have done harm, and it is evident a good dentist should have been consulted, periodically. The stomach should have been called into action three, and not four, times daily. For many, afternoon tea is an insult to their luncheon and a menace to their dinner. I think his dietary was all wrong, but this is a professional matter not to be discussed in these pages. The sad thing is that there was so much suffering while "Malignant Fate sat by and smiled".

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[1] NATURE, 150, 535 (1942).

SCIENTIFIC CENTENARIES IN 1943

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

FOUR hundred years ago, on May 24, 1543, the famous astronomer Nicolaus Copernicus died in the city of Frauenberg, situated on the Fritsches Hof, about midway between Dantzig and Königsberg. He was buried in the cathedral, the centre of the diocese which he had served faithfully through his knowledge of canon law. As he lay on his bed stricken with paralysis, the first copy of his book "De Revolutionibus orbium cœlestrum, Libri VI" was placed in his hands, but it was too late; his memory had gone, his faculties were obscured. The book had lain completed for thirteen years, and it was only through the enthusiasm of the young German mathematician, Joachim Rheticus—whose attitude towards Copernicus was like that of Halley to Newton—that it was at last published. The expense of publishing was borne by Cardinal Schonberg, and to-day the first edition is exceedingly rare. A second edition appeared in 1566, and a third and last in 1617. Copernicus was just over seventy years of age, having been born at Thorn on January 19, 1473. Through his bishop-uncle he was able to study at Cracow, Bologna, Rome, Padua and Ferrara, at the last of which he took his doctor's degree in canon law. He returned north from Italy in 1505, lived at Heilsburg from 1507 until 1512, and from thence onward Frauenberg was his home. There is a statue of him at Thorn and another stands in the interior court of the library of the Jagellonian University, Cracow. A photograph of this was published in NATURE of March 2, 1922, to illustrate an article on "Science in Poland", and the question as to whether Copernicus was a Pole or a German was the subject of remarks in these columns so long ago as December 21, 1871 (p. 151).

A century after Copernicus died, John Bainbridge, the first Savilian professor of astronomy at Oxford, passed away "at his house opposite Merton College in this his 62d year, and his body was conveyed to the public school, where an oration having been pronounced in honour of him by Mr. William Strode, the University Orator, it was carried to Merton College Church and deposited on the left side of Mr. Henry Brigg's grave and an epitaph was inscribed upon his monument in Latin". Before his appointment to the Savilian chair, Bainbridge had taken degrees at Cambridge, kept a school, practised medicine and written on a comet. To what extent he had been influenced by the views of Copernicus we are not told, but his main interest was in Greek and Arabic scientific writings. A foreign mathematical contemporary of his was Habakkuk Guldinus (1577–1643), a Swiss Protestant who became a Jesuit and taught mathematics with success in the Jesuit colleges at Rome and Gratz.

Passing to the year 1743, we are faced with a long list of men of science, of greater or lesser fame, but all of interest. Of these the outstanding figure is Lavoisier, who was born in Paris on August 16, 1743, and fell beneath the guillotine on May 8, 1794. "The spring sends its green leaves and bright weather, bright May, brighter than ever: Death pauses not. Lavoisier, famed chemist shall die and not live: chemist Lavoisier was Farmer-General Lavoisier too, and all the Farmers-General are arrested; all, and shall give an account of their moneys and incomings, and die for 'putting water in the tobacco' they sold." So wrote Carlyle. Twenty-eight Farmers-General and their three assistants were sentenced at one sitting of the Tribunal of the Terror; and it was then that the terrible Coffinhal immortalized himself by replying to Lavoisier: "The Republic requires neither savants nor chemists; the course of justice cannot be suspended". Condorcet (1743–94), author of works on the calculus, and of "The Progress of the Human Mind", perpetual secretary to the Royal Academy of Sciences, only escaped a similar fate by taking poison, but the unfortunate German astronomer, Johan Wilhelm Wallot (1743–94), who had been employed on the testing of Leroy's chronometers and had lectured and observed in Paris for many years, perished on the scaffold on July 27, the day before Robespierre fell and the prisons were thrown open. The 'father' of crystallography, René Just Haüy (1743–1822), born six months before Lavoisier, was at one time in danger, but friends came to his rescue. None took a more active part in the foundation of the metric system than Lavoisier, and in some of his measurements Haüy was associated with him. There is a statue of Condorcet near the French Institute, and statues of Lavoisier behind the Madeleine Church and at the Sorbonne. A reduced replica of the latter is in the National Gallery of Scotland.

The discoveries and theories of Lavoisier were embraced by some chemists and rejected by others, but the credit for their favourable reception in Germany was largely due to the tireless Martin Heinrich Klaproth, who was born on December 1, 1743, and died on January 1, 1817. Klaproth made a host of accurate analyses of minerals and discovered several elements. In 1792, when professor of chemistry in Berlin, he proposed to the Berlin Academy of Sciences to repeat the more important of Lavoisier's experiments. His offer was accepted, and from that time most of the Berlin chemists declared in favour of the new theories. With F. B. Wolff, Klaproth published the first German chemical dictionary. Another French chemist of this time was Antoine-Alexis-François Cadet-de-Vaux, born in Paris on September 13, 1743, whose investigations dealt with matters of domestic economy, public health and agriculture.

In other fields of science occur the names of Antonio Cagnoli (1743–1816), the intimate of Lalande, who had observatories in the Rue Richelieu in Paris and at his birthplace, Verona; of Johan Ferber (1743–90), a learned Swedish mineralogist and traveller; of Colonel James Capper (1743–1825), of the East India Company, who in 1801 published his work on winds and monsoons, and of the two self-taught British mathematicians, John Mole (1743–1827), originally a farm labourer, and Henry Andrews (1743–1820), first a domestic servant and then a bookseller. For forty years Andrews calculated for the "Nautical Almanac", and as the compiler of "Moore's Almanac" raised its sale from 100,000 to 500,000, getting but £25 a year from the not too generous Stationers' Company. Among the other publications of the Stationers' Company was the "Ladies' Diary", begun by John Tipper in 1704. When Tipper died in 1713, Henry Beighton became its editor, and conducted it successfully until his own death in 1743. The "Ladies' Diary" filled a place in the mathematical life of Great Britain in the eighteenth century, and Beighton in his prefaces speaks of it as being "peculiarly adapted for the use and diversion of the fair sex", and of his own "gallant endeavours to introduce his readers to the study of the mathematical sciences". Beighton too has a place in the history of experimental science and of the steam engine.

To complete the review of the bicentenaries which fall this year, mention may be made of the ingenious Rev. Edmund Cartwright (1743–1823), the inventor of the power loom, over which, and other inventions, he lost a sum of £30,000; a Government grant in 1809 of £10,000 made the evening of his life comfortable, and he was afterwards remembered as "a portly dignified old gentleman, grave and polite, but full of humour and spirit".

If for no other reason, the centenaries of men of science who died in 1843 would be of interest inasmuch as they include that of the French astronomer, Jean Nicolas Nicollet (1786–1843), whose intelligence and spriteliness as a boy were maintained throughout his life and led him to have a share in the greatest scientific deception ever perpetrated—the so-called "Moon Hoax". Born to a life of poverty and drudgery, from these Nicollet was rescued by the local curé, and he ultimately gained an education which led him to the librarianship and secretaryship of the Paris Observatory. Grant refers to a "beautiful paper" of Nicollet's in the "Connaissance des Temps", 1822, and to observations he made with Bouvard on the moon's libration in longitude. But it is not for such things he will be remembered longest. Desiring to be rich, he speculated on the Stock Exchange, lost, got into debt and then fled to the United States. That was in 1831. In 1833, Sir John Herschel, with considerable public attention, sailed to the Cape to survey the southern heavens. An unforeseen result was the compilation of accounts of most extraordinary discoveries he had made in the moon. Sir John, of course, knew nothing of them. The ball was apparently set rolling by the Somerset-Cambridge man, Richard Adam Locke, as impecunious as he was versatile and unscrupulous. In 1832, at the age of thirty-two, he too went to the United States, where in 1833 the New York *Sun* made its first appearance. To the editor of the *Sun* Locke proposed an account of Herschel's discoveries in the moon, and so in issue after issue one could read about brown quadrupeds, temples, man bats and what not. The *Sun's* circulation soared and Edgar Allan Poe declared Locke's hoax to be "the greatest hit in the way of sensation . . . ever made by any similar fiction either in America or Europe". At any rate the story made people read, who had never read newspapers before. There is, however, another side to the matter. In Messrs. Sotheran's Catalogue, No. 826, p. 179, there is an entry: "The History of the Moon; or an account of . . . the Rocks, Trees, Flowers, Verdant Plains, Volcanoes, etc." (*c.* 1833), and the authorship of this is attributed by Messrs. Sotheran's to Nicollet, who "published the above account in the New York *Sun* partly to 'raise the wind' and partly to entrap M. Arago, his enemy, into believing it". Did Locke and Nicollet ever meet? Did they collaborate? What is the truth?

Of Alexis Bouvard (1767–1843), called by Miss Clerke "the indefatigable computating partner of Laplace", little seems to be known. He was perhaps the first to conceive the existence of a planet beyond Uranus. Another Frenchman of that time was Silvestre-François Lacroix (1765–1843), mathematical professor at the Collège de France and the Sorbonne. It was the translation by Herschel, Babbage and Peacock of his "Elementary Treatise on the Differential Calculus" which gave the first impulse to a mathematical revival in England. A Swiss mathematician of note who died in 1843 was Ferdinand Rudolph Hassler; Simon Newcomb married Hassler's grand-daughter. After taking part in the trigonometrical survey of Switzerland, Hassler went to the United States, in 1807 was made a professor at West Point Academy and in that same year put forward plans for a survey of the sea coast of the various States; thus he was the virtual founder of that great scientific service, the United States Coast Survey, of which he was the first director. He was born at Aarau in Switzerland in 1770.

Recrossing the Channel to recall some British men of science who died or were born in 1843, we come first to the well-known names of Macintosh, Hedley and Forsyth. Charles Macintosh (1766–1843), the industrial chemist, will always be remembered for his patent of 1823 for making waterproof fabrics by cementing two thicknesses together with india rubber dissolved in naphtha; William Hedley (1779–1843), one of the pioneers of the locomotive, will be remembered so long as his "Puffing Billy" stands in the Science Museum and his "Wylam Willy" stands in the halls of the Royal Scottish Museum, Edinburgh. The work of the Rev. Alexander John Forsyth (1769–1843) on the percussion lock for firearms is recorded on a memorial tablet erected on the walls of the Tower of London in 1930. To these names may be added that of Robert Bakewell (1768–1843), who when geology was first attracting widespread attention lectured up and down the country and wrote excellent text-books, the perusal of one of which awakened Lyell's interest in the subject.

When Herschel arrived at the Cape and set up his observatory at Feldhausen, the Royal Observatory near Cape Town had been nominally in existence since 1821, but no instruments were fixed until some years later. The Rev. Fearon Fallows was the first director and he was succeeded in turn by Thomas Henderson, Sir Thomas Maclear and Edward J. Stone, who in 1879 was followed by Sir David Gill. Gill was born at Aberdeen a century ago next June. Under Gill, who held the post of "Her Majesty's Astronomer" until 1906, the Observatory was completely transformed and it took a leading part in many of the principal projects of the day, including the great Astrographic Chart of the Heavens. Gill was also deeply interested in the measurement of an arc of meridian from the Cape northward through the entire African Continent. His retirement led to little lessening in his activities, and in 1913 he completed his "History and Description of the Cape Observatory". He died on January 24, 1914. Two other astronomers who laboured in the southern hemisphere in Gill's time were Henry Alfred Lenehan (1843–1908), the Government Astronomer of New South Wales and in 1905 president of the Royal Society of that colony, and John Macon Thome (1843–1908), who assisted and then succeeded Gould at the Argentine National Observatory at Cordoba.

Another eminent man of science holding, like Gill, a high official position and born in 1843 was Sir William Chandler Roberts-Austen (1843–1902), the successor of Thomas Graham at the Mint and the successor of Dr. Percy as professor of metallurgy at the Royal School of Mines, London. While assayer at the Mint, he was responsible for the standard fineness of about £190,000,000 of gold, silver and copper coin. He was the first secretary of the Physical Society, president of the Iron and Steel Institute and a Chevalier of the Legion of Honour. Some of his most valuable work was done for the Alloys Research Committee of the Institution of Mechanical Engineers.

To the foregoing may be added the names of Sir John Isaac Thornycroft, F.R.S. (1843–1928), the famous naval constructor and marine engineer; Ralph Hart Tweddell (1843–95), a pioneer of hydraulic tools for shipbuilding, bridge-building, etc.; George Frederick Deacon (1843–1909), a great water engineer who carried through the Vyrnwy Valley project in Montgomeryshire for the water supply of Liverpool; James Campbell Brown (1843–1910), for forty-three years associated with Liverpool as public analyst and as lecturer and professor of chemistry in the University; and finally the name of the eminent Belgian metallurgist, engineer and industrialist, Adolphe Greiner (1843–1915), director of the great Cockerill Works at Seraing, Bessemer medallist and president of the Iron and Steel Institute, who saw his medal and other valuables stolen during the "foul flood" which inundated Belgium a generation ago.

It will not have escaped notice that most of the men included in these notes were workers in the physical sciences. Readers who are more interested in the biological sciences can no doubt recall other workers of renown. One such distinguished man was the famous naturalist, Sir Joseph Banks, who, for forty-one years, was president of the Royal Society. Reference books differ as to the day and year of his birth, but Weld in his "History of the Royal Society" says he was born in Argyle Street, London, "on the 2nd of February, 1743 O.S.". Of the birth of the famous German bacteriologist, Robert Koch, who isolated the bacillus of tuberculosis, there is no such question. He was born at Klausthal in the Harz on December 11, 1843, and died in 1910; an obituary of him appeared in NATURE of June 2, 1910 (p. 402).

NEWS and VIEWS

Wooden Aircraft for War Purposes

IT has been announced that a wooden construction aircraft, the Curtis C.76 known as the Caravan, has just been completed in the United States, being the first of its kind, in that country, to be designed especially for war transport purposes. It is a high-wing monoplane, powered with two 1,200 h.p. engines. It carries two pilots and a radio operator, and has a large cabin space suitable for the carriage of troops, guns, or other military equipment. The body is built specially low when standing on the ground, and the doors are arranged to facilitate the quick transfer of the contents. Outlets specially suitable for paratroops are also provided. An interesting feature of this development is that it represents, with several British contemporaries the most notable of which is the Mosquito day bomber, a return from metal to wooden construction that has taken place since the outbreak of war.

The immediate pre-war policy of the Air Forces of most countries was to use metal construction (1) because it allowed a rapid expansion of output along mass-production lines, (2) because of its relative immunity from fire due to enemy bombing of large concentrations in store. War experience has almost completely reversed these. In the case of (1), the need for constant progress in design makes real mass production prohibitively wasteful in labour and materials allotted to production machinery, tools, etc. It also neglects a large reservoir of wood-working labour and machinery that has not so great a use in any other sphere of war production. With (2), the large concentration of war material close behind the static lines preparatory to an attack is no longer needed, partly because warfare has proved to be more fluid; also the speed at which it has been proved that aircraft can be concentrated at any given point allows it to be dispersed in store over a wider area. Another field for wooden aircraft is that of pure transport, distinct from fighting or bombing. The rapid carriage of troops or material to points where needed for fighting operations can proceed far enough away from the enemy to be reasonably safe from interference on a large scale, and the high speeds of the aircraft allow it to take evasive action to avoid isolated attack from occasional enemy machines. Thus a machine designed to a transport specification rather than a war one becomes the ideal, and in this case wood construction has many advantages.

Short-Wave Broadcasting: Transmission

SIR NOEL ASHBRIDGE, controller of the Engineering Division of the B.B.C., gave an account of "Short-Wave Broadcasting: Ten Years Technical Progress", in the Overseas Service of the Corporation on December 17. Sir Noel said that it is about eleven years since the B.B.C., in spite of inconclusive reports on the existing service, decided that an attempt should be made to build up a regular short-wave service to the countries of the British Empire, trusting to an improvement in both transmission and reception to make it justifiable. The bare principles on which the first station was designed did not differ in essentials from the much bigger stations which several countries are operating to-day. Wave-lengths in several groups within the limits of 13 to 50 metres are still used, except for the 100-metre transmissions to Canada, which are only used to overcome somewhat special conditions. Again, the principle of transmitting on directional beams, taking various parts of the world in turn, following the clock, still more or less applies to-day. No striking new invention has arisen to revolutionize the technique, but a great deal has been learned about the design of aerials, and how to construct them so that they radiate a beam of the right width and depth and as nearly as possible at the right angle to the earth, so that they will be reflected back to earth by the ionosphere, and arrive in that part of the world where they are intended to be received. The first experimental transmitter used only one wave-length, and the new station completed ten years ago used eight wave-lengths. We are now using no less than forty-four. The hours of transmission, too, are strikingly different; the first station with its two transmitters sent out twenty-three transmitter hours per day; but now the number of transmitter hours per day is more than three hundred and fifty-six. There was only one language used with the first station, as against nearly fifty at present.

Reception and Rediffusion

Big developments have also taken place at the receiving end. At the beginning, short-wave receivers were looked upon almost as scientific instruments which were of little use to people with no particular interest in technical matters. Even super-heterodyne receivers were comparatively rare only ten years ago, and undoubtedly it was the development of this type of receiver, with efficient automatic volume control and simplified tuning, which has done a great deal to convert a highly speculative undertaking into what may now fairly be called a firmly established institution. Another important factor has been the growth in the rediffusion of programmes by wires connecting a number of houses to a central receiving station. Such a station can be an elaborate and costly affair embodying the very best technique in short-wave reception. Such undertakings exist in many parts of the Empire, for example, Malta, and notably in the West African colonies. Somewhat similar advantages are gained by rebroadcasting through a local broadcasting station. The Empire and North American Services transmit for a total of nearly 149 hours a week, and are rebroadcast by wireless stations for nearly 55 hours, and when we include wireless exchanges this figure rises to more than 130 hours. Two pioneers who were instrumental in establishing wireless exchanges in several of the Colonies were Sir Arnold Hodson, recently governor of the Gold Coast, and Mr. F. Byron, an engineer in the Colonial Service.

The Future

All this development, both on the transmitting and receiving side, has taken place well inside ten years, and is not solely due to the War. What will be the future of short-wave broadcasting? Will people still go on listening and searching to see what they can find coming from distant countries? There is not much doubt that for some time they will, since news must be foremost in everybody's mind for many years to come. The question remains what will happen when and if news becomes a matter of less pressing importance to the whole world? Is short-wave broadcasting capable of further development, purely as a means of recreation and enjoyment? Whether the results obtainable by this means will ever be equalled by an ordinary direct listener in his home would at first sight seem doubtful, but if the progress in the next ten years is anything like that in the last ten years, we may look forward to the day when reception from far-off countries is almost as good as from the local station, and a few years after that we may even see the addition of pictures.

Nottingham Open Forum

An experiment successfully conducted in Nottingham during the last two months has aroused considerable local interest, and might well find favour in other towns and cities. The Nottingham Open Forum was sponsored by the British Council, in co-operation with University College, Nottingham, and the Ministry of Information, as an attempt to attain a better understanding and closer contact between local residents and visitors from overseas, both civilians and allied troops; and to stimulate informative discussion on matters of general interest. A series of meetings on 'Brains Trust' lines, but on a broad international basis, was arranged, and organizations such as the International Centre, the British Empire Club, the Polish Troops' Club, the Rotarians, Y.M.C.A. and Y.W.C.A., etc., were invited to co-operate, as well as the general public. It was felt that the public to-day prefers to be stimulated to think for itself rather than to be 'lectured at' and told what to think. The promoters of the Nottingham Open Forum have no political bias and are therefore free in their choice of subjects and speakers, and the members of each panel can express their views without reserve however controversial they happen to be. This type of meeting naturally has a much wider appeal than the usual 'public meeting' which is seldom free from the taint of propaganda. The information-seeking public is surely entitled to be at least as well catered for as the amusement-seeking public, and the successful presentation of any open forum or 'Brains Trust' depends largely on the care with which it is organized.

In Nottingham, "International Relations" was chosen for the first Open Forum; the audience was then invited to submit suggestions for future topics. This resulted in a wide variety of subjects from which the committee selected those of most general interest, including "Local Government", "The British Commonwealth", "Science and Modern Life", "Books, Writers and Readers", "Social Democracy", "Education: for whom and for what?", "Town and Country Planning", "National and International Law", etc. It is of obvious importance that the panel of speakers should be well-balanced and as representative as possible of the various aspects of each topic under discussion. For example, with "Local Government" as the subject, the panel consisted of a city councillor (Independent), the Deputy Town Clerk, an American city manager, a woman member of the City Council (Conservative), with a Labour M.P. (ex-chairman of the L.C.C.) as guest speaker. Much depends upon the question master, who introduces the speakers, and generally 'controls' his team. Questions are invited from the public, and an average number of about thirty are sent in for each meeting. It has been found that a good panel can deal with about ten questions in an hour, so the Committee gives careful consideration to selecting those questions which cover the most ground and provide the greatest variety. The audience particularly appreciates an opportunity of submitting written supplementary questions. Stewards (provided with pencils and paper) collect these during the session, and the last twenty minutes are devoted to dealing with them in a brisk 'sharp-shooting' fashion. One important feature of the Nottingham Open Forum is that the members of the panel meet for a few minutes before the public proceedings begin, when they are given a list of the questions. This avoids any confusion as to who shall answer each question first, and provides an opportunity for the speakers to decide when they can best make their own special contributions, while in no way destroying the spontaneity of their answers. The Open Forum has attracted an audience of from three hundred to four hundred at each meeting, and the enthusiasm shown has been gratifying. Especial appreciation has been expressed by foreign nationals from the occupied countries who are much impressed by the 'free speech' permissible in Great Britain. Further information can be obtained from the Secretary of the Nottingham Open Forum, Mrs. R. B. Calder, 5 Western Terrace, The Park, Nottingham.

Charles L. Mayer Awards for Animal Cell Growth Research

DR. WILLIAM J. ROBBINS, chairman of the National Science Fund of the U.S. National Academy of Sciences, has announced the creation of two 2,000 dollars prizes to be known as the Charles L. Mayer Awards and to be presented in 1942 and 1943 for outstanding contributions to our knowledge of factors affecting the growth of animal cells with particular reference to human cancer. The awards are to be not only in recognition of past accomplishments but are also designed to increase the opportunities of those with exceptional abilities to carry on further research. To assist the National Science Fund in effective administration of the Mayer Awards, a special advisory committee has been appointed consisting of Dr. R. R. Williams, chemical director of the Bell Telephone Laboratories, Dr. Alan Gregg, director for the Medical Sciences of the Rockefeller Foundation, Dr. George H. Whipple, dean of the School of Medicine and Dentistry of the University of Rochester, and Dr. Elihu Root, jun., as the lay member. The donor of the Charles L. Mayer Awards, Dr. Robins said, had in mind the vast possibilities offered by research on the action of chemical agents and physical factors in stimulating or retarding cell growth, and the National Science Fund would consider studies of factors controlling the growth of protozoa, of animal tissue cultures or of entire organisms as eligible.

In announcing the establishment of these Awards, Dr. Robbins directed attention to significant work which has been done on the amino-acids and some of the more recent discoveries on the importance of the rarer mineral elements, for example, manganese and copper, as necessary for animal cell development. Recent advances in the identification and isolation of some of the vitamins and hormones have opened new vistas for the student concerned with the control of growth. Along with the increased knowledge of factors stimulating growth there have been significant contributions to our information about growth-inhibitors such as the sulpha drugs and the anti-vitamins. Dr. Robbins emphasized that the Committee is interested primarily in fundamental studies on the factors influencing growth of animal cells rather than applications to any particular aspect of normal or abnormal growth. Applications based on such studies may develop in the future but at present we need more knowledge of the essentials concerned. Reports of empirical success in treatment of human cancer will not be eligible for the awards. The Advisory Committee will welcome suggestions at once as to outstanding published contributions and manuscripts of 1942 on any phase of this subject, at the National Science Fund offices, 515 Madison Avenue, New York City.

National Coal Board

AT the first meeting of the National Coal Board held on December 21, Major the Right Hon. Gwilym Lloyd George, Minister of Fuel and Power, presided. He pointed out that the establishment of the Board completes the final stage in the Government's plan for the war-time reorganization of the industry in Great Britain. The Board would advise the Minister, in whose hands control of the industry is vested, and he appealed to members of the Board to approach the problems with which they would deal from a national point of view, and on the basis of national service. Sub-committees were appointed for dealing with the following matters: (1) The general planning of production, including the allocation of district and regional targets. The best means of securing the highest efficiency of the coal-mining industry and any improvements in machinery or methods of operation whereby output may be increased. (2) The provision of supplies, equipment and materials for the conduct of mining operations. (3) Matters relating to the maintenance of man-power and labour productivity, including the enrolment of new entrants and the instruction, training and advancement of boys and youths. (4) All matters affecting the welfare of mine-workers, including housing, transport and feeding facilities; and questions of health and safety and, in particular, such occupational diseases as silicosis and nystagmus, with the view of providing all possible preventive measures, clinical treatment and rehabilitation.

The Turkish Earthquakes

EVER since the great Turkish earthquakes of December 27, 1939 (NATURE, **145**, 13; 1940), it has been noted that the earth-blocks in the affected district have never really attained their final position of rest. Aftershocks of the 1939 earthquake were frequent, of considerable amplitude and protracted. These followed the normal course, consisting of large shocks of gradually decreasing severity, interspersed with numerous minor shocks and tremors. Aftershocks, however, normally finish some months after their 'parent' shock and subsequent earthquakes with adjacent epicentres must be regarded as discrete. As recently as December last (NATURE, **150**, 687; 1942) renewed seismic activity in Anatolia was noted.

Ciorum appeared to have been the most affected during the preceding month, though Balikesir was also damaged. During this time about 20 people were killed, 24 injured, 1,600 houses totally wrecked and some further 1,300 partly wrecked.

The most recent very strong earthquake took place on December 21, 1942, and the epicentre appears to have been slightly to the east and very close to Erba. This place is approximately a hundred miles to the east of Ciorum, and west-north-west of the epicentre of the very severe 1939 (Erzinjan) earthquake. On the recent occasion Erba was almost completely destroyed, partly by the earthquake and partly by the fires which followed it, and it is feared that more than a thousand people have perished. Niksar, east of Erba, also suffered severely, as did the intervening villages. Erba is the centre of a rich tobacco-growing region about eighty miles south-east of Samsun on the Turkish Black Sea coast, and about 280 miles east of Istanbul. The strong shocks were also felt severely in Ordu, Sivas, Kastamuni, Bakir-chai, Tokat, Fatza, Kaisarieh and Zara, though no major damage is reported from the last-named place.

North African Natural History

As suggested earlier in the War, the armies in North Africa have stimulated much useful war-time observation of fauna and flora in otherwise difficult regions, and the current issue of *Countryside* (12, No. 5) contains original papers by members serving abroad. These include notes on the birds of the British list wintering in West Africa by A. C. Allnutt, who noticed that while whinchats wintered in the coastal region for the whole of the six winter months, the willow-warblers arrived in waves of migration and remained only a few days. Blue-headed and grey-headed wagtails were there from December until February but no nuptial songs were heard. Their feeding habits were no different from those observed in Europe. Waders seen regularly included the marsh-sandpiper, ringed plover, greenshank, bar-tailed godwit, black-winged stilt; those seen mainly on passage were the sandpiper, curlew-sandpiper, grey plover, redshank, spotted redshank, little stint, turnstone and sanderling. Migrating sandwich terns remained for several weeks, and the arctic skua and black tern were noted. Previous numbers of this volume of *Countryside* have contained notes on the birds of Tobruk. In the current issue Col. W. R. Roberts has notes on the flora of the Egyptian wadis near Cairo.

Fruit Growing

Allotments and gardens, though small units of horticultural production, are now so numerous that their aggregate contribution to the nation's nutrition is not small. The Ministry of Agriculture and Fisheries has recently issued "Growmore" Bulletin No. 7, "Fruit from the Garden" (H.M. Stationery Office, 3*d*. net, 1942) to assist the small grower to increase his production of fruit. Mr. J. M. S. Potter, of the Royal Horticultural Society, has written the text, which deals adequately with the planting and general management of stone fruits, apples and soft fruits. The bulletin's advice is eminently suited to the southern parts of Britain, but northern growers should not be advised to "avoid the strong growers like Bramley's Seedling and Newton Wonder". These varieties are often the most suitable for difficult climates. Many small apple orchards in the north are also unproductive because of the relative scarcity of other trees for pollination, and it is disappointing to find scant mention of suitable pollinating kinds for each variety. A useful spraying calendar is given, and sections on picking and storing, pruning, and the treatment of old trees also appear. Fruit culture is never so economically successful as when practised on a domestic scale, and it is good to see the Ministry's recognition of this important fact.

Planning of Science: in War and in Peace

The Association of Scientific Workers is organizing a conference to be held on January 30 and 31, at the Caxton Hall, London, S.W.1, on the planning of science in war and in peace. Sir Robert Watson-Watt, president of the Association, will open the Conference. The first session will deal with the central direction of scientific research and development, and Sir Stafford Cripps has agreed to speak. It is also hoped to have statements on the organization of science in the U.S.A. and the U.S.S.R. The second session will be devoted to the local organization of scientific research and its application; among the speakers will be Mr. W. C. Devereux, managing director of High Duty Alloys, and Mr. Ben Smith, national organizer of the Association, who will speak on the relationship between managements and scientific staff as it affects production; detailed consideration will be given to the relations between scientific and other workers and to the work of joint production committees. The third session will discuss those changes in the organization of science brought about during the War which may have a continuing effect on the relations of science with society, and the re-orientation of science after the War. Prof. P. M. S. Blackett and Sir Lawrence Bragg will be the main speakers. The chair will be taken by Prof. J. D. Bernal. Tickets (2*s*. 6*d*. for whole conference or 1*s*. per session at the door) and full particulars can be obtained from the Conference Secretary, Association of Scientific Workers, 73 High Holborn, London, W.C.1.

Announcements

No. 3 of the War Background Studies issued by the Smithsonian Institution is by Dr. Aleš Hrdlička and is devoted to an account of the peoples of the Soviet Union. While there is nothing in these twenty-nine pages which purports to be new matter, the little publication gives a very convenient conspectus of the early history and make-up of the peoples of the U.S.S.R. It is compiled for the general public.

The following appointments and promotions in the Colonial Service have recently been made: J. F. A. Sprent, veterinary research officer, Nigeria; I. H. Pattison, veterinary officer, Palestine; J. R. Curry (agricultural officer, Tanganyika Territory), director of agriculture, Bahamas; M. Greenwood (specialist (chemistry), Agricultural Department, Gold Coast), senior specialist, Agricultural Department, Gold Coast.

The Institution of Naval Architects is offering two scholarships in naval architecture (Elgar Scholarship, £130 a year, and Denny Scholarship, £100 a year) and two in marine engineering (Parsons Scholarship, £150 a year, and Yarrow Scholarship, £100 a year) for competition in 1943. The age limit for the Denny Scholarship is nineteen, and that for the other scholarships twenty-three. Particulars can be obtained from the secretary of the Institution, 10 Upper Belgrave Street, London, S.W.1.

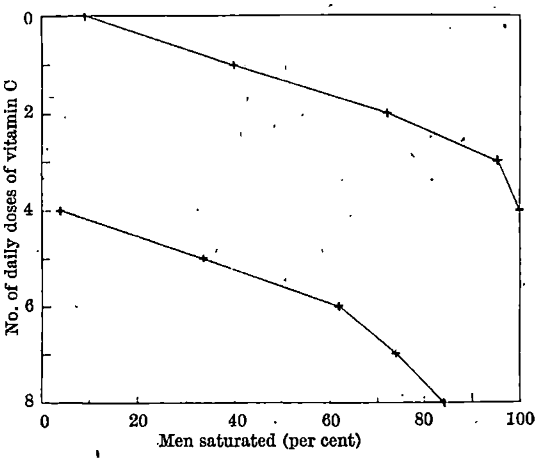
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Vitamin C Saturation Test of Harris and Abbasy

DURING a year's service in the R.A.M.C., six months were occupied exclusively in carrying out and reporting upon this test[1] according to a scheme drawn up by the Directorate. Though the results concerning the 1,200 men examined cannot be given, some remarks on the method appear to be worth recording as based on experience gained in performing some thousands of titrations; also a couple of points accidentally discovered may be mentioned.

Much time is saved by having the fourth and fifth hours, after dosing with ¾ gm. of the vitamin, as the period of retention of urine and by making up the sample to ½ or one litre, instead of having the often inconveniently long three-hour period and measuring the volume of each sample. The 2 : 6 dichloro-phenol indophenol reagent is best adjusted so that 1·0 ml. corresponds to 0·1 mgm. of vitamin. By these small alterations several weeks of simple arithmetic were eliminated in the second tour.



The method was found to give consistent results capable of distinguishing between groups of 100 men living under slightly different conditions of vitamin C intake. These differences are clearly shown when one plots on the vertical axis the number of daily doses required to approach saturation, namely, an excretion of 35 mgm. of vitamin in a two-hour period, and on the horizontal the total percentage of men who have reacted before and on that day. The forms of the curves are shown in the accompanying figure, in which the upper relates to a population extremely well supplied with vitamin C and the lower to a badly fed one, in which those with the lowest reserves are approaching frank scurvy; cases of scurvy require about ten doses to become saturated, and no information is given about the 16 cases below the 8-dose limit. These curves do not represent conditions in the Army. Their importance lies in the fact that they show an appreciable personal variation existing in a population on a fairly uniform diet, and make it clear why some, and not all, of a ship's company become affected with scurvy. Severe muscular exercise is known to produce scurvy in those low in reserves of vitamin C, so possibly some men use up more than others, or minor differences in tastes or in cooking may be responsible.

There remains the question of the individual assimilation of the vitamin ingested. This may be very unequal. Information on this point was obtained through an accident. Two sections of men belonging to the same unit and feeding from the same cookhouse responded very differently to the doses, for one showed its peak of saturation about two days earlier than the other. The numbers, 22 and 21 respectively, appeared to rule out a chance aggregation. This remained a puzzle until on returning to the station four months later it was ascertained that a visiting unit was dosed after the first section, and that the second home section had breakfast before being dosed. Apparently the vitamin suffers less destruction when taken after food. A direct experiment should be made to test this accidental finding.

Additional evidence was obtained that this vitamin, unlike vitamin D, is not stored in quantity for long. For it was found that those dosed at one station in May included about 40 per cent dosed four months previously. When three lists were prepared (*a*) those saturated in January, (*b*) all those previously dosed, (*c*) those not dosed before, three curves were obtained, roughly parallel, with *a* uppermost, then *b* and *c*, but only about ¾ of a dose separated *a* from *c*. Thus there were men in class *c* with much higher reserves than in *a*, though after *a* had been saturated all lived on the same diet.

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Dec. 13.

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[1] Harris, *et al.*, *Lancet*, 1, 71 (1935); 2, 1429 (1937); 1, 642 (1942).

Vitamin C Saturation Test: Standardization Measurements at Graded Levels of Intake

DR. ATKINS's valuable account of his experiences with the saturation test prompts me to send a brief summary of my own unpublished observations bearing on two of the points to which he alludes: first, the degree of 'scatter' in the responses seen in different subjects kept on the same or similar intakes; secondly, the choice of criteria to be used.

In my own tests, groups of boys (12–36 in each group) at a residential home were kept on a basal diet of known vitamin C content and given in addition various graded supplements of vitamin C, natural and synthetic, over periods of 3–4 months or longer, so that each boy in a group received identically the same intake. About twice a year (an interval found to be sufficiently long to allow the effect upon their 'reserves' of any previous saturation test to have become negligible), the boys were tested by the standardized procedure previously described[1], 700 mgm. per 10 stone being given daily and the number of days counted until the approach of saturation (taken as an excretion of 50 mgm. or more per 10 stone in the 2¼-hour specimen collected in the fourth and fifth hours after each test dose).

Results were found to be graded, as follows: daily intakes of 75, 60, 50 and 45 mgm. gave first-day responses of decreasing magnitude; 40 mgm., first to

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second-day responses; 25 mgm., second to third-day responses, the 'scatter' in the responses of subjects kept on the same level of intake being small (see table). In earlier tests, children on still lower intakes had third-day to fifth-day responses. Similar graded results have been recorded with adults on varied intakes, patients with scurvy taking 7–10 days to saturate.

Date	Daily intake of vitamin C (mgm.)	Total number of boys in group tested	No. of boys approaching saturation			
			1st day	2nd day	3rd day	4th day
Autumn 1941	75	12	12	0	0	0
	60	10	10	0	0	0
	45	10	9	1	0	0
Spring 1942	50	12	12	0	0	0
	40	11	5	6	0	0
	25	12	0	5	7	0

As a standard of reference in assessing results of surveys, it is noted that an intake corresponding with the League of Nations requirement (30 mgm.), or an amount not greatly in excess of it, suffices in nearly all subjects to give responses on the first or second day of dosing. The number of days beyond the second may be taken as an index of the relative deficit in the past intake. For high and low base lines respectively, it is observed that with intakes of the order of 50–75 mgm. per day (the optimal standard recommended by some American authorities), saturation is attained on the first day of dosing, whereas with intakes appreciably below the League of Nations standard three days and upward are needed, reaching a limit of seven to ten days for cases of developed scurvy. These criteria agree with those previously suggested[1].

It is hoped to publish the extended data elsewhere.

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Dec. 11.

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[1] Harris, L. J., *Lancet*, 1, 642 (1942).

Vitamin C Intakes at a Residential Home

Since July 1941 we have been making a study[1] of the vitamin C in the diet at a residential institution (home for waifs and strays at Cambridge), in order to obtain information about the day-to-day intakes, the influence of seasonal fluctuations in the supply of available sources, the effect of the War, etc. Chemical analyses were made on representative specimens of the various cooked and raw foods served and the results used to calculate each day's total intake. From time to time complete meals were analysed as a further check on the calculated values, and the agreement was good (average 'predicted' result was 110 per cent of average 'determined' result).

The average daily intakes (in mgm.) were as follows: 1941: July, 23; August, 35; September, 55; . . . 1942: January, 24; February, 27; March, 19; April, 19; May, 23; June, 24; July, 42; August, 53; September, 53; October, 38; November, 35. The pronounced difference between the intakes in summer and winter was reflected in the results of saturation tests (first-day response in all instances after summer, as compared with second to third-day response in all instances after winter).

The change from old to new potatoes in late July (1942) or late August (1941) made an addition of about 30 mgm. per day. The other notable cause of the higher values in the summer was the increased use of garden produce, for example, cabbage, cauliflower, spinach and some fruits.

Apart from potatoes, important because of their regular use and the relatively large amounts consumed, the principal source of vitamin C throughout the year was provided by the green vegetables, such as cabbages and sprouts. Cooked vegetables had an advantage over raw in that much larger quantities could be eaten and assimilated. The water in which the vegetables had been cooked was utilized for preparing gravies, etc., and also furnished an important supply of vitamin C.

In this institution dietary practice was particularly good, with the result that the vitamin C intakes and levels of nutrition, as determined by saturation tests[2], were considerably higher than average working-class values.

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Mamie Olliver.

The Laboratories,
Chivers and Sons, Ltd.,
Histon.

Dec. 11.

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[1] Harris, L. J., and Olliver, M. (in the Press).

[2] Harris, L. J. (above).

Stability of Ascorbic Acid in Dehydrated Vegetables

In the interesting leading article on "Food Storage and Transport" in Nature of August 22, 1942, there is a statement that "dried vegetables keep their ascorbic acid for some months when exposed to air". Clearly the stability of ascorbic acid in dehydrated vegetables, which will usually be consumed several months after manufacture, is of essential importance and needs careful investigation. Tests carried out on material immediately after dehydration give little indication of its antiscorbutic value under war conditions.

In recent experiments carried out in my laboratory, commercially dehydrated (steam-blanched) vegetables were kept for several months in an incubator at 37° C. in sealed (not exhausted) tins. The tins, containing samples from a consignment of each of the vegetables processed on one particular day, were opened at intervals for testing. It was found that dehydrated cabbage, cauliflower, and knol-khol lost 50 per cent of the ascorbic acid originally present in the dehydrated material in 12 weeks. The samples were stored at 37° C. to simulate tropical conditions. In other samples of these vegetables stored in closed but not sealed tins at Coonoor room temperature (say 18°–23° C.), the loss was 70–75 per cent in 6 weeks.

These samples took up some moisture, which may have accelerated destruction of ascorbic acid; the vitamin appears to be more stable in material which remains *crisp*. In a sample of dehydrated potato stored at room temperature in an unsealed closed tin the loss was only 10 per cent in 12 weeks. The stability of vitamin C in dehydrated vegetables in relation to conditions of packing and storage, the method of 'scalding', time of dehydration, etc., obviously requires further investigation.

Even in dehydrated amla fruit (*Phyllanthus emblica*), powdered, in tablets, and vacuum-packed, steady though slow loss of ascorbic acid occurs on storage. Amla, unlike common vegetables and fruits, contains tannins which have a protective effect on ascorbic acid. The loss in amla is slower than in the case of common vegetables, but the fact that loss does occur under such conditions suggests that ascorbic acid is unlikely to be very stable in other dehydrated vegetables and fruits not packed in containers from which oxygen has been excluded.

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I.R.F.A., Coonoor.
Oct. 30.

Urea Synthesis in Mammalian Liver

BACH and Williamson[1] claim to have shown that rat liver forms urea from ammonium lactate even when the activity of arginase is inhibited by high concentrations of ornithine[2]. They conclude that liver can synthesize urea without the participation of arginase.

The data presented by Bach and Williamson are capable of a different interpretation. A relevant feature of their experiments is the extraordinarily low activity of arginase. According to their graphs 3 and 4, 1 mgm. liver (wet weight) formed 1·26 μgm., or 0·75 μgm., urea per hour, the first figure referring to an arginine concentration of 12·4 mgm. per cent, the second of 7·5 mgm. per cent. The potential arginase activity of rat liver under similar conditions, that is, at the same arginine and *p*H, is shown in Table 1[3].

TABLE 1. ARGININE ACTIVITY OF RAT LIVER AT DIFFERENT ARGININE CONCENTRATIONS (*p*H 7·4; 0·025 *M* PHOSPHATE BUFFER; 4 ML. TOTAL VOLUME; 40 MINUTES INCUBATION AT 40°).

Concentration of arginine	Urea nitrogen formed by 1 mgm. (wet weight) ground rat liver
1112 mgm. per cent	369 μgm.
556 „	371 „
278 „	347 „
139 „	265 „
69·5 „	180 „
34·8 „	117 „
17·4 „	75 „
8·7 „	43 „

TABLE 2. ARGINASE ACTIVITY IN THE EXPERIMENTS OF BACH AND WILLIAMSON COMPARED WITH POTENTIAL ARGINASE ACTIVITY.

Arginine concentration	Arginase activity (μgm. urea nitrogen formed per mgm. wet liver per hour)	
	Potential activity	Bach and Williamson
12·4 mgm. per cent	88	1·3
7·5 „	63	0·8

The comparison of the arginase activity observed by Bach and Williamson with the potential activity obtained by graphical interpolation from Table 1 shows that no more than a minute fraction—about 1·3 per cent of the total arginase—was active in the experiments of Bach and Williamson (Table 2); presumably it was only the arginase from the surface layer of the slices or from disintegrated cells which reacted. The inhibition by ornithine refers to this fraction only. The bulk of the tissue arginase—more than 98 per cent—did not come into play in the inhibition experiments of Bach and Williamson. These, therefore, do not show that the arginase in their liver slices was inhibited, and it is thus unnecessary to conclude that there is a urea formation without arginase.

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Nov. 25.

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[1] Bach, S. J., and Williamson, S., NATURE, **150**, 575 (1942).

[2] This inhibition was first observed by R. E. Gross (*Z. physiol. Chem.*, **112**, 236; 1920). L. Hellerman and C. C. Stock (*J. Biol. Chem.*, **125**, 771; 1938) suggest that it may be due to the formation of metallic complexes of ornithine.

[3] The activities vary somewhat with sex, age and other factors, but are always of the same order of magnitude (see E. Baldwin, *Biol. Rev.*, **11**, 247; 1936; H. D. Lightbody, *J. Biol. Chem.*, **124**, 169; 1938).

IT seems scarcely possible to compare the activity of arginase observed with intact cell material suspended in bicarbonate buffer with that of ground tissue in phosphate buffer. There is also no linear proportionality between arginase activity and weight of slices[1].

If part of the arginase activity in the experiments with slices was caused as Krebs suggests by 'disintegrated cells', this criticism could surely be more justifiably applied to his experiments with ground tissue.

Krebs's criticism leads to the assumption that the 'tissue arginase' is incapable of decomposing added arginine but is active in the formation of urea from added ammonium lactate (via arginine). No explanation is given for this hypothetical difference.

Details of our work will be given elsewhere in due course.

S. J. BACH.
S. WILLIAMSON.

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Cambridge.
Dec. 8.

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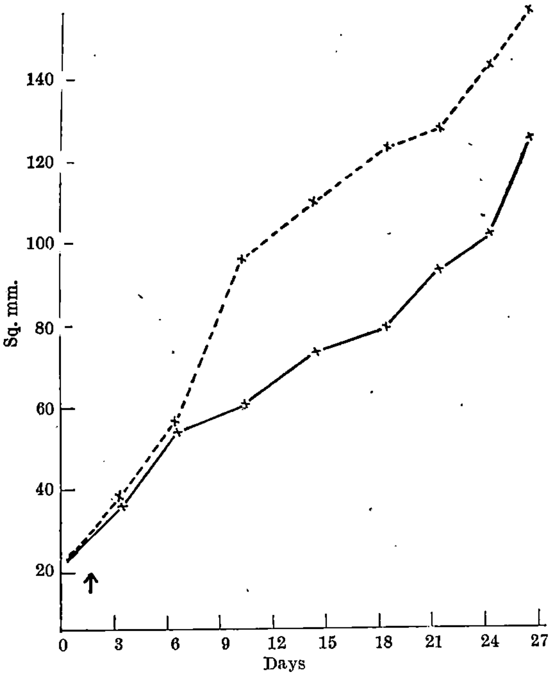
[1] Leuthardt, F., and Koller, F., *Helv. chim. Acta*, **17**, 1030 (1934).

Growth Stimulators in Urinary Extracts

IN a recent communication by Werner and Doljanski, the growth-promoting effects of certain tissue extracts upon tissue cultures are described[1]. The methods of extraction indicate that the active extracts may contain protein or protein-associated groups.

It may be of interest to note that in the fractionation of the growth-inhibiting extract of urine, H. 11 Extract[2], which is now being used in the treatment of cancer, certain fractions have been obtained which are stimulatory to the growth of transplanted tumours. Such fractions are protein-free and can contain only substances of relatively low molecular weight. It therefore seems likely that non-protein growth-promoting substances are present in the tissues.

An example of such a stimulatory solution is that obtained when neutral H. 11 Extract is fractionated by precipitation with copper salts. Extraction of this precipitate with dilute hydrochloric acid yields an insoluble tarry substance which is partially soluble



- - - - - - - Treated (average of 7 tumours).
———— Untreated (average of 10 tumours).

Extract given in doses of 0·5 c.c. b.d. intraperitoneally. First injection 11 days after inoculation.

Tumour size evaluated as product of two diameters.

in sodium hydroxide. The alkali-soluble part is found to be growth acceleratory, as indicated by the accompanying graph.

As these results were only incidental to the main research on substances inhibitory to cancerous growths, no further investigations were made. It is felt desirable, however, to record them for the use of other research workers in this field.

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P. F. HOLT.
R. FORBES JONES.

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Dec. 7.

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[1] NATURE, 150, 660 (1942).

[2] *Medical Press and Circular*, 205, 334 (1941).

The 'Age' of Terrestrial Matter and the Geochemical Uranium/Lead Ratio

IN 1937 Stefan Meyer[1], of the Radium Institute in Vienna, using the data then available, obtained a value for the 'age' of the sun, or rather of terrestrial matter (assumed to be of solar origin). Assuming matter to have taken on its present elementary composition when radioactive disintegration was also started, Meyer calculated the length of time required for producing all the uranium- and actinium-lead in existence through disintegration of uranium I and of actino-uranium respectively. In his calculation Meyer made use of the figures for the isotope ratios of uranium and lead determined by the mass spectrograph, and also of the geochemical uranium/lead ratio worked out by Goldschmidt. Finally, he assumed the activity ratio between the uranium and the actino-uranium series to be as 25 : 1. The result gave $(4 \cdot 6 \pm 0 \cdot 4) \times 10^9$ years as the age of the sun and, incidentally, the half-period of actino-uranium was found to be $(7 \cdot 0 \pm 0 \cdot 5) \times 10^8$ years.

Thanks to recent very accurate measurements by J. O. Nier[2], it is now possible to revise these calculations. Also the half-period of U^{235} has been found by independent methods ($7 \cdot 1 \times 10^8$ years). Using the latter value, the calculation can be carried out without using the hypothetical value of the geochemical uranium/lead ratio, which can be determined instead through the calculation. From Nier's determination the following constants are used: Isotope ratio of lead $Pb^{204} : Pb^{206} : Pb^{207} = 1 \cdot 5 : 22 \cdot 6 : 22 \cdot 6$; Decay constant of actino-uranium, $\lambda_{acu} = 9 \cdot 72 \times 10^{-10} a^{-1}$; Isotope ratio of uranium, $\frac{U^{238}}{U^{235}} = \beta = 139 : 1$.

From the law of radioactive decay it follows that:

$$\lambda_U t_a = \ln U_a / U_0. \quad . \quad . \quad . \quad . \quad (1)$$

If U_a was the number of uranium atoms t_a years ago and U_0 their present number, we find

$$U_a = U_0 + \alpha_u \Sigma Pb. \quad . \quad . \quad . \quad (2)$$

From equations (1) and (2):

$$t_a = (1/\lambda_u) \ln(1 + \alpha_u \Sigma Pb / U_0). \quad . \quad . \quad . \quad (3a)$$

For the actinium we find a similar equation

$$t_a = (1/\lambda_{acu}) \ln(1 + \alpha_{acu} . \beta . \Sigma Pb / U_0), \quad . \quad . \quad (3b)$$

where λ_u is the decay constant of uranium ($1 \cdot 535 \times 10^{-10} a^{-1}$), α_u the ratio $Pb^{206} / \Sigma Pb = 0 \cdot 226$ and α_{acu} the ratio $Pb^{207} / \Sigma Pb$ is $0 \cdot 226$.

By a graphical method we find from the preceding equations $t_a = 5 \cdot 33 \times 10^9$ years, whereas the geochemical lead/uranium ratio is found to be 5·6. It should be observed that the latter figure is derived directly from the radioactive constants. It agrees fairly well with Goldschmidt's assumption that per 100 atoms of silicon there are 0·0008 atoms of lead and 0·00016 atoms uranium present, giving a lead/uranium ratio of 5 : 1. We further find the present-day lead/actino-uranium ratio to be 750 : 1, whereas the uranium/urano-actinium ratio at the starting point, 5·33 billions of years ago, should have been as 1·78 : 1.

The age of matter thus found is seen to agree with the short-time scale now generally adopted in cosmic physics. It is of the same order of magnitude although numerically less than the new maximum age for iron meteorites given by Paneth[3] at $7 \cdot 8 \times 10^9$ years.

The figure here found for the age of terrestrial matter obviously represents a *maximum*, since any non-radioactive genesis of the lead isotopes Pb^{206} and Pb^{207} would mean a corresponding reduction in the time required for their production through disintegration. On the other hand, the age as stated only applies to the uranium isotopes, leaving the possibility open that when they were evolved the other elements may have existed for an indefinite time.

F. F. KOCZY.

Oceanografiska Institutet,
Göteborg.
Oct. 29.

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[1] Meyer, S., *Mitt. Inst. Radiumforschung*, No. 393, No. 407.

[2] Nier, J. O., *Phys. Rev.*, 55, 150, 153 (1939); 60, 112–116 (1941).

[3] Arrol, W. J., Jacobi, R. B., and Paneth, F. A., NATURE, 149, 235 (1942).

Effect of Air Currents, Light, Humidity and Temperature on Slugs

In view of the communication by Kalmus[1], it is of interest to record a brief summary of results obtained during an attempt to determine the causes of activity in slugs. The results will be considered under four headings, namely, responses to (1) air currents, (2) light, (3) humidity, and (4) temperature.

(1) *Air Currents.* A gentle draught of air (just perceptible to the observer's cheek) was played across the path of slugs (*Agriolimax reticulatus* and *Limax maximus*) just in front of the animals. The slugs turned away, going through the following movements. The tentacles were withdrawn, the head moved to right or left and the tentacles extended again. This process was repeated until the tentacles eventually remained extended and the animal moved away from the draught, presumably because the tentacles were no longer stimulated. Air played on the tail or body of the slug increased the speed of locomotion or, if the animal was at rest, induced activity. The same result was obtained using saturated air, showing that the effect was not due to the temperature drop (see below) caused by the evaporation of water which occurs when dry air is used. Air currents thus have a dual effect: (*a*) stimulation of the tentacles affecting the direction of locomotion, and (*b*) stimulation of the body or tail affecting the occurrence or speed of locomotion.

The above effects were readily demonstrated on a specimen of *Limax maximus* moving over a glass plate. Observation of the sole showed that stimulation of the tentacles by air currents involved immediate inhibition of the locomotory waves, while stimulation of the body or tail initiated waves or increased their speed. This inhibition of the locomotory waves by anterior stimulation is in accord with experiments in which a posterior half of a slug, completely severed from the head end, produced locomotory waves without ceasing for two hours after isolation.

(2) *Light.* In some instances slugs (*A. reticulatus*) kept at constant temperature in the dark showed increased activity when illuminated by electric light, though the increase was never as marked as in the temperature responses described below. The effect was short-lived, adaptation occurring quickly. In the final experiments using 72 animals at a time and noting activity at 15-minute intervals (instead of 5-minute as in previous experiments) no effect was obtained, possibly because adaptation occurred within 15 minutes. (In considering these experiments it is necessary to remember that a light was used for taking the readings in the dark, and the animals were thus illuminated for occasional short periods (1–2 minutes). The animals showed a typical avoiding reaction at the boundaries of well-defined regions of bright light. The boundary was, however, traversed if this was the only way in which the slug could avoid facing into a draught (see above).

(3) *Humidity.* At room temperature (16–18° C.) slugs (*A. reticulatus*) were found to be no more active at high than at low humidities. No orthokinesis comparable with that described by Gunn[2] in the woodlouse or by Pielou and Gunn[3] in the mealworm was observed. Slightly greater activity was obtained at low humidity. This may be explained as a response to the fall in temperature (see below) which occurs when a damp object is introduced into a dry atmosphere.

Humidity might affect the animals indirectly by altering their water content. Experiments on *A. reticulatus* and *L. maximus* showed that when loss of water by evaporation and mucus production exceeded a certain minimum value, the distance moved after the animal was transferred to an arena was reduced. The nature of the normal habitat of slugs makes it unlikely that such a reduction in water content would occur owing to evaporation alone, particularly as slugs can be shown to absorb water readily from damp objects with which they are in contact. Loss of water by mucus production may affect the occurrence of activity, and since mucus is produced during locomotion, may also limit its duration. Howes and Wells[4] observed weight fluctuations due to water content in *Arion ater* living under laboratory conditions but made no correlation with activity.

(4) *Temperature.* Slugs (*A. reticulatus*) respond readily to temperature changes. No correlation was observed between degree of activity and temperature when the latter was kept constant. Activity was, however, invariably stimulated by rising temperature above a critical value of about 20° C. Below this value the effect was reversed and activity stimulated by falling temperature. (In both cases the rate of rise or fall was about 1° C. in 10 minutes.) If the temperature was kept constant at any value, the activity fell to a low level. Some evidence has been obtained that temperature changes towards the critical value of 20° C., that is, in the reverse direction to those above, reduce activity below the level observed at constant temperature.

The results of these and related experiments will be published in detail elsewhere.

BARBARA H. DAINTON.

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Dec. 8.

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[1] Kalmus, NATURE, 150, 524 (1942).

[2] Gunn, *J. Exper. Biol.*, 14, 178 (1937).

[3] Pielou and Gunn, *J. Exper. Biol.*, 17, 307 (1940).

[4] Howes and Wells, *J. Exper. Biol.*, 11, 326 (1934).

Discoveries by Accident

It is not derogatory of a discoverer to say that his discovery arose from an accident; for the power to use accidents, events the occurrence of which was not intended, is the mark of one form of scientific genius. Probably all experimenters are presented with about the same number of accidents which, if they had had the wit, would have led them to important discoveries; but most of us fail to appreciate their significance until the discovery has been made by somebody else; we may then fail to remember them or forget them to save our self-respect. I know that I had at least three such accidents that would certainly have led Röntgen to discoveries, if not as important as X-rays, at least of considerable technical and scientific interest. Two of them I missed entirely, and the third I used very imperfectly.

Doubtless there is another form of scientific genius that proceeds from triumph to triumph according to an ordered plan; but it is seldom certain that the progress was really as orderly as it appears when the results are presented. Even if this form must be reckoned the higher, science would never have reached its present position without the other.

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Dec. 18.

RESEARCH ITEMS

South African Bored Stones

A. J. H. GOODWIN, of the University of Cape Town, has given an account of the bored stones of South Africa in No. 1 of the new series of Communications from the School of South African Studies published by the University of Cape Town. Bored stones are of various kinds—as described in the article—but, generally, may be visualized as balls of stone so pierced that they can be hafted on to sticks, which are then used for digging or other purposes, the weight of the stone materially assisting the operation. The age of these bored stones varies considerably, some being quite modern and some of unknown antiquity, and culturally speaking they have been used by Bantus, Bushmen and prehistoric peoples. They are figured in some of the so-called Bushmen paintings. The present article analyses a large amount of material and will be very useful for reference purposes to students of South African Stone Age archæology.

New Palæolithic Industry from East Anglia

AN interesting paper on a new palæolithic industry from the Norfolk coast appears in the *Geological Magazine* (79, July–August 1942) under the names of D. F. W. Baden-Powell and J. Reid Moir. The problem of the number and relationships of the various glacial deposits in Norfolk has evoked much literature, but this short article may well be preferred to some of the longer treatises. For the first time, the Corton sands at Corton are properly taken into account and correlations made between the deposits there and at Hoxne. A very interesting flint industry found in the "Corton" sands at Runton and hence named *Runtonian* is also described. The artefacts are apparently usually small and include neatly trimmed round scrapers, points, etc. The whole industry might perhaps be assigned to an early Clactonian culture since it certainly belongs to the flake-tool culture group, and plain, unfaceted striking platforms are the rule. It is to be hoped that Baden-Powell and Reid Moir will not rest content with this small article; it should be treated as a synopsis to a more comprehensive work on the prehistory of these parts of East Anglia.

Biology of the Brown Trout

THE results of the research by A. E. J. Went and Winifred E. Frost form the fifth of the series of the survey of the River Liffey begun by the late Rowland Southern and continued after his death in 1935 by Miss Frost (River Liffey Survey, V. Growth of Brown Trout (*Salmo trutta* L.) in Alkaline and Acid Waters. *Proc. Roy. Irish Acad.*, 48, B, No. 4; 1942). Variation in the size of brown trout from different localities has given rise to much discussion. In general, in waters of low *p*H values the trout were small and slow-growing, whereas in limestone waters they were of the large quick-growing type. The present work is based on sets of scales together with other data relating to length, weight, sex, date of capture, etc., most of which have been collected by Miss Frost from brown trout taken by angling in the River Liffey and its tributaries. The main part of the material was obtained from Straffan (alkaline water, mean *p*H 7·9) where the trout were of relatively large size, and from Ballysmuttan (acid water, mean *p*H 5·5) where they are seldom more than four ounces in weight. It is suggested that the difference in growth-rate in the two localities is mainly due, not, as it is often considered, to the age of sexual maturity, which is found to differ little, but to a longer period of rapid (summer) growth and more active growth during the period of slow (winter) growth at Straffan than at Ballysmuttan.

Subantarctic and Antarctic Algal Communities

C. SKOTTSBERG describes the communities of marine algæ in subantarctic and antarctic waters (Kungl. Svenska Vetenskapsakademiens Handlingar. Tredje Serien. 19, No. 4; 1941). The work is based on his personal observations during the Swedish Antarctic Expedition (1901–1903) and the Swedish Magellanic Expedition (1907–1909). The algal communities were practically unknown in the regions visited except that the 'kelp belt', the association of *Macrocystis pyrifera*, had attracted attention for centuries. This, the most famous of all southern communities, ranges from the Peruvian coast to Cape Horn and is circumpolar in the antarctic, forming a belt outside the breakers but approaching close to the shore in smooth waters. It was a great misfortune that the major part of the antarctic collection was lost with the ship in the pack-ice of Paulet Island. A large amount of work, however, has still been possible. The four districts concerned—South America from Chiloë to Fuego, the Falkland Islands, South Georgia and West Antarctica ("Graham Land")—are treated separately and there are distinct differences in the algæ of these regions. There are some interesting deep water communities. The red algæ dominate in deep water, whereas the littoral species often show a brownish violet tinge. The author believes that, judging from his own material, in the antarctic at least a small number of red algæ are able to exist at a depth greater than 40 m., especially as the Desmarestia association extends to almost this depth, but that there are no special deep-water species justifying the recognition of a separate elittoral algal region, and that records from below 50 m. need corroboration.

Genetics of the Potato

SEVERAL viruses of the potato cause a lethal necrosis of some varieties when these are grafted on to infected stocks. This necrosis only occurs on those varieties which are intolerant of the virus, and which rarely, if ever, carry the infection in the field. C. H. Cadman (*J. Genetics*, 44, 33–52; 1942) has shown that the products of top-necrosis due to virus X after grafting occur in those varieties which carry a dominant gene Nx. This gene segregates in an autotetraploid manner; the occurrence of equational exceptions and the statistical examination of the segregation ratios show that Nx is situated far from the centromere. It should be possible to raise varieties which are intolerant, that is, practically immune from virus X.

Great Iron Boulder from Ovifak

H. Löfquist and C. Benedicks give a detailed account of the core from the great iron boulder brought by Nordenskiöld from Ovifak to Stockholm ("Det Stors Nordenskiöldska Järnblocket fran Ovifak: Microstructur och Bildningssätt." Kungl. Svenska Vetenskapsakademiens Handlingar. Tredje Serien. 19, No. 3; 1941). This huge mass of 25 tons belongs to the Mineralogical Department of the State Museum of Natural History (Riksmuseet) and was successfully drilled out in 1938. The core obtained was divided into five specimens and a complete metallographic investigation was made. Chemical analyses of samples taken close to these specimens show that the iron boulder consists of nickel-bearing, sulphur-rich massive iron with a high carbon content, making a natural raw iron. The microstructure, on the whole, agrees well with the analytical results, and minute investigations were made on all the constituents. The general conclusion is that there are strong reasons for the view that the iron boulder has been formed from iron sulphide to which carbon has been added. The genesis of the Ovifak boulder may be explained as the result of the following contact-metamorphosis: "One of the boulders of the nickeliferous pyrrhotite of the neighbourhood has happened to be enclosed in a crack in which molten basalt has risen, after having absorbed carbon from the coal beds broken through. . . . Under the combined action of the high temperature of the magma and its carbon, the sulphides of the pyrrhotite have been dissociated, giving carbon-rich iron, i.e., a natural crude iron containing nickel, being Ovifak iron." This work is in Swedish with an English summary.

Crystal Structure of Phosphorus Pentachloride

THERE is proof from electron diffraction experiments that the molecules of some phosphorus pentahalides have the configuration of a trigonal bipyramid, and the same configuration is found for a number of other molecules of similar formula. The appreciable electrical conductivity of solutions of phosphorus pentachloride and other observations suggest that it may be able to exist in an ionized form. The physical properties of the solid lend support to this idea, and a comparison of the Raman spectra in various states shows that the bipyramidal molecules do not persist in the solid. An examination of the X-ray spectrum by D. Clark, H. M. Powell and (independently) A. F. Wells (*J. Chem. Soc.*, 642; 1942) has now given the very interesting result that in the crystal the substance exists in ionic form. The unit cell is tetragonal and contains tetrahedral PCl_4^+ and octahedral PCl_6^- groups. These are arranged in a structure essentially of the cæsium chloride type, but distorted, since the ions are not spherical. The structure bears some resemblance to that of tetramethylammonium iodide but belongs to a lower symmetry class of the tetragonal system. The phosphorus to chlorine distance varies from 2·06 A. in PCl_6^- to 1·98 A. in PCl_4^- and is interpreted as related to change of effective nuclear charge. The P to Cl distance in PCl_4^+ is short by about 0·08 A. of the length calculated from the sum of the normal tetrahedral covalent radii derived from methyl compounds, with a correction for charge. Similar shortenings have been observed for many halogen compounds.

Estimation of Added Calcium Carbonate in National Flour

AT a meeting of the Society of Public Analysts and Other Analytical Chemists held on November 4, E. N. Greer, J. D. Mounfield and W. J. S. Pringle described "The Estimation of Added Calcium Carbonate (Creta Praeparata) in National Flour". Three methods have been studied and are described: (*a*) The sample is incinerated and calcium is determined in the ash by precipitation as oxalate and titration with permanganate; a blank estimation should be made on a sample of the same flour without added Creta. (*b*) The sample is treated with excess of standard hydrochloric acid and the excess titrated back with alkali; with this method also a blank estimation is necessary. (*c*) The carbon dioxide liberated by excess of hydrochloric acid is absorbed and weighed. If a control sample of the unfortified flour is available, the oxalate method is the most accurate; without a control sample the error may be as much as 20 per cent. Method (*b*) also requires a control sample and when the amount of Creta is about 7 oz. per sack the method is accurate to 3–4 per cent. Method (*c*) is accurate to within about 3 per cent even in absence of a control, and this method is therefore the most useful of the three.

Crystal Structure of Graphite

A FURTHER discussion of the faint extra lines found on X-ray powder photographs of well-crystallized graphite by Taylor and Laidler (NATURE, 146, 130; 1940) is given by H. Lipson and A. R. Stokes (*Proc. Roy. Soc.*, A, **181**, 101; 1942). A new structure is proposed having hexagonal layers similar to those of graphite, but arranged in a different sequence. About 14 per cent of the new structure is present in the samples examined, ranging from natural graphite from Ceylon, Bavaria and Travancore to graphite extracted from the 'kish' occurring in the casting of carbon-rich steels as well as in graphite crystallized by arcing.

Obscured Regions in the Greenwich Astrographic Zone

IN a paper on this subject (*Mon. Not. Roy. Astro. Soc.*, **102**, 5) E. G. Martin gives the results of the separate counts for the Greenwich region (Dec. +64° to +87°, galactic latitude +4° to +51°), originally published in vol. 4 of the *Astrographic Catalogue*. A comparison of the average log N_m at different latitudes and longitudes with the figures by van Rhijn provides some very interesting results. The frequency curve shows that there is a considerable amount of asymmetry, negative residuals being in excess. On the assumption that the scatter is due to accidental error, the probable error in log N_m of a single count for regions at latitudes exceeding 25° is $\pm 0{\cdot}102$, and for those less than latitude 25° it is $\pm 0{\cdot}122$. There are twenty-nine regions in which the negative residuals are larger than three times the probable error, the largest residual being eight times the probable error, and it is considered that this is due to a real absorption effect. Nineteen of the outstanding regions are spaced in latitudes 4° to 20°, and only ten lie between latitudes 20° and 50°; this confirms the hypothesis that absorption increases towards the galactic equator. Among the five strips selected in galactic longitude to derive the separate mean values of log N_m, it was found that there is a tendency for the central strips to contain more outstanding regions than the outer strips, indicating a higher absorption around longitude 90°–100° and confirming a secondary maximum. It is very difficult to determine how much the absorption for each individual count amounts to in magnitude and also to find at what distance the absorption is effective, owing to the fact that actual counts are available only from magnitudes 10 to 13. An attempt was made to analyse the mean results of the counts for latitude 7°, and, while the result showed a density near the sun similar to that given by van Rhijn up to 1,000 parsecs, at 10,000 parsecs the density rapidly increased to a much larger value than that of van Rhijn.

TRACE ELEMENTS IN RELATION TO HEALTH

THE eighth scientific meeting of the recently formed Nutrition Society, or fifth of the English group, took the form of a whole-day conference at the London School of Hygiene and Tropical Medicine, on "Trace Elements in Relation to Health".

Dr. J. Russell Greig occupied the chair at the morning session, opening the proceedings with a brief reference to his own interest in 'pining' of sheep in Scotland. Prof. C. Harington took the chair at the afternoon session and finally summed up the day's discussion as a whole. Ten papers provided by fourteen contributors were included on the agenda paper, all of which will be published in due course in the *Proceedings of the Nutrition Society*.

(1) *Significance of Trace Elements in Relation to Diseases of Plants and Animals.* In this paper Dr. H. H. Green, of the Veterinary Laboratory of the Ministry of Agriculture at Weybridge, offered a 'bird's-eye view' over the whole field of trace elements of known economic importance in both plant and animal life, intended to serve as an introduction to the more specialized papers to follow. Commencing with a definition of 'trace element' as any element regularly occurring in minute amounts in living tissues whether it exercises any specific physiological function or not, metals such as aluminium and nickel were cited as apparently inert and merely present because incidentally taken up by the action of plant roots; elements such as copper and manganese cited as essential for both plants and animals, boron as essential for the plant but not known to be essential for the animal, cobalt as essential for cattle and sheep but not yet known to be essential for non-ruminants or for plants, selenium and molybdenum as probably unessential for both plants and animals but sometimes taken up by healthy plants in amounts which cause disease in the consuming animal.

Omitting elements such as lead and arsenic which, though known to be toxic, are not absorbed by plants in amounts dangerous to animals, and passing over the essential element iodine as "trace but no longer novel", the elements copper, cobalt, manganese, zinc and boron, were dealt with in some detail as involved in deficiency diseases, and fluorine, selenium and molybdenum as causing toxicoses.

The occurrence of relevant plant and animal ailments in various parts of the world was summarized, local names, prominent symptoms and methods of control being mentioned. Control varies from fertilizing apple trees with borax in Tasmania for control of 'internal cork', or pine trees in Australia for 'needle fusion', top-dressing pastures with copper sulphate for control of 'Urbarmachungskrankeit' in crops and 'Lecksucht' in animals in Schleswig-Holstein, or for control of 'falling disease' of ruminants in Australia, providing copperized salt licks to breeding sheep for protection against 'sway-back' of lambs in England or 'enzootic ataxia' in other parts of the world, supplying cobalt to prevent 'wasting disease' of cattle and sheep in Australia, 'Grand Traverse disease' in Michigan, and 'pining' in Scotland, to controlling the 'alkali disease' of Dakota or the 'blind staggers' of Wyoming by eradicating plants which take up excessive quantities of selenium from seleniferous shales and act as 'selenium converters' by finally returning that toxic element to the soil in a form more available for other plants.

The quantities of essential trace elements in plants are, however, no necessary indication of the quantities required by consuming animals, and animals may waste away when grazing on luxuriant herbage or complete the cycle of their being on plants showing obvious symptoms of vegetative failure.

(2) *Distribution of Trace Elements in Soils and Grasses.* Dr. R. L. Mitchell, of the Macauley Institute, near Aberdeen, pointed out that a very large number of elements is present in soils, each in traces of fractional parts per million upwards, but that the amount of any one of them may vary a thousand-fold from soil to soil. The variations correspond to the parent material from which the soil is derived, in the last resort from igneous rocks and the magmas from which they have crystallized; but certain geochemical rules prevail, and if any particular trace element occurs in a rock there must be present in it a mineral at least one of the constituents of which can be replaced by an atom of the element in question. For this reason elements such as cobalt, nickel and chromium would be expected in higher quantities in ultrabasic rocks than in acidic rocks, where elements such as barium would be more prevalent. If the origin of a soil can be directly traced to an igneous formation, it is possible to forecast the probable occurrence of its trace elements, but in practice the problem is complicated by weathering and metamorphosis and if, as often the case in north-east Scotland, the surface is derived by glacial drift from sedimentary rocks, the problem becomes individual for each soil considered. These points were illustrated by discussing the range of trace elements found by spectrographic analysis of Scottish soils, in respect of silver, barium, cobalt, chromium, cæsium, copper, gallium, germanium, lanthanum, lithium, manganese, molybdenum, nickel, lead, rubidium, tin, strontium, thorium, titanium, vanadium, yttrium and zirconium.

The occurrence of a given trace element in a soil, however, is not necessarily a guide to its occurrence in plants, and although there exists a general correlation between soil quantities soluble in dilute acetic acid and quantities found in the covering vegetation, trace-element deficiency diseases are sometimes found in plants growing on soils containing abundance. The natural *p*H of the soil is an important factor, as evidenced by the lime-induced 'chlorosis' of plants found in parts of England.

In general, trace-element deficiencies of plants and grazing animals can be rectified by incorporating small amounts in fertilizers, as little as 2 lb. per acre of a cobalt salt being sufficient to prevent the 'sheep pining' of certain pastures in Ross-shire. Among plant diseases in Scotland associated with trace elements were mentioned boron deficiency of turnips and sugar beet in the west and manganese deficiency leading to 'oat sickness' in the north.

(3) *Copper, Zinc and Other Trace Elements in Relation to Physiological Function and Enzyme Systems.* Dr. H. Mann, in this paper with Prof. D. Keilin, pointed out that, of the numerous trace metals detectable in tissues, definite physiological functions have so far only been assigned to iron, copper and zinc. To these, several distinct purposes can be assigned, of analogous character in all three cases. They either form oxygen carriers or catalyse reactions involving oxidation, reduction, or acid-base equilibrium. In each case the metal has definite physiological properties only when stoichiometrically bound with highly specific protein molecules which, although themselves inactive, determine the pro-

perties of the metallo-protein compounds and can be limiting factors in their formation. It is the specific protein which determines whether the trace element is to function as carrier of molecular oxygen in the circulating fluid or as catalyst promoting intracellular oxidation in the tissues, or perform any other function.

In dealing with iron, Dr. Mann discussed the rare iron-protein hæmerythrin, the commoner iron-porphyrin-protein oxygen-carrier hæmoglobins and myoglobins, the green hæmoglobin chlorocruorin of certain molluscs, and the oxidizing catalysts cytochrome, peroxidase and catalase. Among the copper-protein compounds are the blue oxygen-carrier hæmocyanins of some arthropods and molluscs, the oxidizing catalysts such as the phenolic oxidases which account for the rapid darkening of fruits and vegetables on bruising, and of insect cuticle after emergence from the pupæ. The function of the hæmocuprein of red blood cells is not yet known, although copper is recognized as essential for hæmoglobin formation. In the case of zinc, only one enzyme is yet recognized, the carbonic anhydrase of blood corpuscles, gastric mucosa, pancreas and other tissues. Its function is to catalyse the reversible dissociation of carbonic acid into carbon dioxide and water, and so facilitate the removal of oxidation products and the maintenance of acid-base equilibrium in the body. The fact, however, that the distribution of zinc is not strictly coincident with that of carbonic anhydrase suggests other zinc-protein compounds with other functions.

Of special interest is the enormously high activity of the trace metals in the form of their specific protein compounds. The enzymes are active when present as parts per thousand million, a level at which neither the metal itself nor the protein itself can be detected by any known chemical means.

(4) *Enzootic Ataxia or 'Swayback' of Lambs in England in Relation to Copper Feeding of Ewes During Pregnancy.* This contribution took the form of a cinematographic film illustrating the Derbyshire investigations of a group of workers under the general co-ordination of Prof. T. Dalling, recently translated from the chair of animal pathology at Cambridge to the directorship of the Veterinary Laboratory of the Ministry of Agriculture at Weybridge, into a disease of lambs termed 'swayback' in Britain and 'enzootic ataxia' in Australasia and other parts of the world. The disease can be controlled by supplying copperized salt during pregnancy to outwardly healthy ewes, the lambs of which otherwise develop the disease during fœtal growth and suffer high mortality incidence in the first week of life. Although the precise role of copper is not yet clear, the quantities of that element in the blood of affected lambs and their mothers is below that of unaffected controls. Unlike certain Australasian pastures, however, affected Derbyshire pastures cannot be incriminated as grossly deficient in copper.

The film illustrated the characteristic spastic paralysis of limbs with resultant inco-ordination during life, and the pathological lesions found at post-mortem. The latter comprised symmetrical demyelination of the cerebrum and secondary degeneration of the motor tracts of the cord.

(5) *Cobalt and Other Trace Elements in Relation to Disease in Australasia.* This paper, read by Dr. H. Chick on behalf of Sir Charles Martin, who had personal experience of animal diseases in Australia during his sojourn there about a decade ago. placed in historical perspective the classical researches carried out over the last fifteen years in that continent into diseases of cattle and sheep caused by deficiency of cobalt, of copper, or of both combined.

Along the coast of South and West Australia, areas occur in patches long known by farmers to be unsuitable for rearing ruminants, although they enjoy a rainfall of 20–40 in. and produce abundant herbage throughout the growing period. Animals could be fattened on them but not reared, since if confined to them for more than a few months cattle and sheep began to weaken, without characteristic lesions to suggest a cause, finally dying of starvation in the midst of apparent plenty. In South Australia the soil of these unsound areas consists of unconsolidated wind-blown sand and shells; in West Australia of loamy granitic gravel about five miles from the coast at an altitude of 500 ft. In the latter area the disease was termed 'enzootic marasmus' by Filmer, who found that, like the 'bush sickness' of New Zealand formerly attributed by Aston to iron deficiency, it can be prevented and cured by mineral licks containing the iron ore limonite. Very poor response, however, was given by therapeutic treatment with pharmaceutical iron salts, and in following up this observation Filmer subjected the limonite to chemical fractionation. Extracts freed from iron but containing zinc, nickel and cobalt were as active as the original material and trials of these elements separately led to the discovery that enzootic marasmus is a cobalt-deficiency disease preventable by administration of so little as 0·1 mgm. daily for sheep and 0·5 mgm. for cattle.

Parallel researches by Marston and others in West Australia were complicated by differences in symptomatology. In addition to the progressive weakness of enzootic marasmus, ataxia proceeding to complete inco-ordination of limb movements was observed, particularly in lambs and young sheep, and shown by Bull to be associated with demyelination of spinal tracts. After much exhaustive testing of possible causes, from poisonous plants to gross mineral imbalance, a trace element factor was suspected and Jansen's salt mixture, containing zinc, nickel, cobalt, manganese, aluminium, boron, arsenic, molybdenum and copper, along with the usual major elements, was tried. This gave excellent results, and by a process of elimination it was finally ascertained that the required combination was copper and cobalt. Unless both were included the experimental controls succumbed within a year.

Further investigation showed the occurrence of copper deficiencies alone, notably the enzootic ataxia of lambs in West Australia, while the bush-sickness of New Zealand was then found to be due to deficiency of cobalt and not iron. Arising from the Australasian investigations, similar diseases were then identified in many other parts of the world, including the long known 'renguerra' of Peru and the 'swayback' in restricted areas of England.

(6) *Sheep 'Pining' in Britain.* Mr. W. Lyle Stewart, veterinary investigational officer at Newcastle, dealt mainly with the occurrence of 'pine' in Northumberland, a wasting disease of sheep associated with anæmia. This is treated as the result of interaction between malnutrition and helminth infestation. Neither factor alone is sufficient to account for death. In fairly large-scale experiments a small ration of mineralized cake containing a variety of trace elements, including copper and cobalt, reduced incidence of the disease, and periodic dosing with anthelmintics achieved the same effect, but much

the best results were obtained by combining both treatments. In another series of experiments equally good results were obtained by combining fortnightly dosing with mixed trace elements in solution and monthly dosing with phenothiazine as anthelmintic. Live-weight gains of lambs over a short experimental period were 27 lb. for the controls, 31 lb. for trace element dosing, 36 lb. for anthelmintic treatment, but 41 lb. for the combined treatments.

(7) *Fluorine in Human Nutrition.* Biochemical aspects were dealt with by Dr. M. M. Murray, a clinical account of fluorine distribution was provided by Dr. D. C. Wilson, and radiological investigations were reported upon by Mr. F. H. Kemp.

Dr. Murray dealt briefly with sources of fluorine in drinking water, the main cause of chronic endemic fluorosis manifested most clearly as 'mottling' of teeth; and with compounds such as fluorspar and cryolite causing industrial fluorosis, characterized by osteosclerosis. It was pointed out that fluorine occupies a curious position nutritionally in that very small traces appear to be beneficial, whereas larger traces seriously interfere with bone metabolism. More fluorine was found by American workers in sound teeth than in carious teeth, and 'mottled enamel', occurring where fluorine in drinking water reaches about 1 p.p.m. during the period of development of teeth, is more resistant to caries. Fluorine affects the bones at all ages; adult workers exposed to industrial risk develop osteosclerosis but not mottled teeth. Little is known about the precise action of fluorine, but the low concentration at which it inhibits osteogenesis suggests a catalytic effect. Traces of fluorine can pass the placental barrier, and disorganization of calcification occurs in the fœtuses of experimental rats on high fluorine intake.

Mr. Kemp showed lantern slides illustrating cases of human skeletal fluorosis, including 'round back' of children and adults in areas of Great Britain in which mottled teeth are prevalent. It was not claimed that high fluorine intake is alone responsible for interference with spinal ossification in children, but merely that high fluorine in drinking water may influence development of such defects.

Dr. Wilson discussed the relationship between fluorosis and nutritional status, stating that although mottling and staining of teeth are proportional to the amount of fluorine in drinking water, the state of nutrition of the individual determines the character of the enamel and regularity of dentition. Nutritional status also influences the skeletal lesions in chronic endemic fluorosis, and dietary surveys in India have shown much more severe lesions in poor villages than in prosperous neighbouring communities. For early treatment of 'round back' associated with dental fluorosis of children in Oxfordshire, good results can be expected by combining school meals with attention to posture in physical training.

(8) *Industrial Fluorosis of Animals in England.* Under this title Mr. F. Blakemore, veterinary investigational officer at Cambridge, described an outbreak of industrial fluorosis in farm animals extending for about a mile in the direction of the prevailing winds from a high concentration of kilns in a brick-making district of England. Analysis of pasture grass and other plants showed surface contamination with fluorine compounds and this was traced to the flue gases drifting down from the chimneys, and thence to the high fluorine content of the clay used in brick-burning. Cattle are most severely affected and typical cases show lameness and enlarged atrophic bones with fluorine content up to 16,000 p.p.m.; mottling of the permanent incisors occurs in most cattle within the affected belt. Urinary fluorine is high even in animals without pronounced clinical symptoms, and its estimation in catheter samples has proved an excellent method of mapping affected farms. On removal of clinically affected animals from the district, urinary elimination of fluorine continues above normal, with rapid clinical improvement. The content of fluorine in surgically removed bone fragments fell rapidly over the first three months, but over the following five months showed little change from the residual high level.

A few parallel observations in the Manchester smoke belt showed no evidence of fluorosis at all.

(9) *'Teart' of Somerset: a Molybdenosis of Farm Animals.* Mr. W. S. Ferguson, one of the three Jealott's Hill investigators who established the etiology of this disease a few years ago, described the condition as one only affecting ruminants, chiefly dairy cows, and characterized by scouring and progressive cachexia. The dung becomes watery, foul and greenish yellow; hair covering of Red Devon cattle turns dirty yellow, and that of black beasts a rusty colour. Affected areas comprise about 20,000 acres in central Somerset associated with the Lower Lias geological formation, and smaller regions in north Somerset, Gloucester and Warwick. Spectrographic examination of affected pastures reveals abnormally high molybdenum, up to 100 p.p.m. on the dry matter as compared with 5 p.p.m. for healthy pastures, and the degree of 'teartness' is directly related to the water-soluble molybdenum content, which is highest in lush young grass and lowest in old herbage. The analytical conclusions were supported by reproducing the disease experimentally, by dosing with calculated amounts of sodium molybdate and by top-dressing sound pasture to raise the molybdenum content to that of affected pastures.

In searching for an antidote, it was found that oral ingestion of 2 gm. copper sulphate per cow per day prevents scouring and permits grazing of teart pastures throughout the season. Explanation of the mode of operation of the copper, and of the limitation of the molybdenum effects to ruminants, awaits further investigation.

(10) *Absorption and Excretion of Trace Elements.* Miss E. M. Widdowson, reading a joint paper with Dr. R. A. McCance, pointed out that there are no special characteristics in regard to absorption and elimination of trace elements except in so far as these can be deduced from their known chemical properties. Both absorption and excretion of silver as a trace element are limited by the insolubility of its chloride; in the case of barium by the insolubility of its sulphate. If divalent and capable of forming insoluble phytates and phosphates, as in the case of zinc and manganese, they tend to behave like the physiologically abundant calcium. If monovalent and characterized by solubility of their salts, they behave like the alkali metals or the halogens. The soluble milligram or so of lithium in daily human food behaves exactly like the concomitant 5,000 mgm. of sodium. Elements which cannot be excreted by the kidney in virtue of attachment to serum proteins will react alike, and zinc or manganese will tend to behave in the same way as iron.

The difficulties inherent in determining absorption and excretion of any element while the cycle of ingestion, intestinal absorption and partial return to he intestine by bile and digestive juices is in progress were stressed, and further parallels drawn between relatively abundant elements such as calcium and magnesium and trace elements such as trontium, tin, cobalt and nickel.

In his final summary of the day's discussion, Prof. C. Harington reviewed a number of the salient eatures in the light of his own experience of the history of development of the physiology of iodine, tressing the point that although much information on the importance of various trace elements may accumulate, final conviction concerning the significance of any particular one does not really penetrate he scientific consciousness of the community until precise physiological function becomes clear and the actual operative mechanism is biochemically demonstrated.

T. DALLING.
H. H. GREEN.

STAR MAGNITUDES AND IMAGE DIAMETERS IN PHOTOGRAPHIC PHOTOMETRY

FORMULÆ hitherto employed to determine the relationship between star magnitudes and image diameters on photographic plates have been empirical, and fail in certain circumstances. It is impossible to apply them in the case of bright stars which give diameters larger than a certain limiting value (and his value varies with different formulæ) and, in ddition, the formulæ take no account of the effect f star colours. D. L. Edwards has described a new method of investigation which gives very satisfactory esults (*Mon. Not. Roy. Astro. Soc.*, **102**, 5). The work was carried out at the Norman Lockyer Observatory, Sidmouth. Three different Zeiss triplet lenses were used: (*a*) aperture 14 cm., focal-length 70 cm.; *b*) aperture 10·4 cm., focal-length 50 cm., (*c*) similar o (*b*) but stopped down to 2 cm. aperture. The plates used were the Barnet Super Press (blue sensitive mulsion), and Ilford Hypersensitive Panchromatic, which gives a good scale of photovisual magnitudes without a filter. When the panchromatic plates were onsidered and measured diameters were plotted gainst H.D. visual magnitudes (only stars of ype *A*0 being used to determine the form of the elation for one colour only) the empirical formula $m=a-b(D-kD^2)$ gave the best fit. In this formula m is the magnitude, D the diameter, and a, b, k are onstants.

Measures made on Barnet Super Press plates were reated in the same way, except that photographic instead of photovisual magnitudes were used, and it was found that the above relation held as for the photovisual plates. In addition, the same values f k were also applicable, in spite of the different magnitude scales and of the different types of mulsion used. Good values of k were given by $=10^{-5}(140-13C)$, where C is the colour index.

The advantage of the first formula given above is hat it has a greater range of application to bright tars than earlier formulæ, and it also allows for olour effect.

Edwards has applied this formula to γ Cassiopeiæ. The series of photographs extended over the period June 1, 1940, until March 24, 1942. During 1940 the magnitude variations were more pronounced, but by the end of the year and also throughout 1941 they tended to become steadier. Considerable changes in the spectrum accompanied the more pronounced fluctuations. At, and just preceding, the minima of June 29, 1940, photovisual magnitude 2·76 and photographic magnitude 2·64, and also of September 21, photovisual and photographic magnitude each 2·53, the *H* lines showed well-separated double emission components with strong central absorption and rather faint 'dish-shaped' absorption fringes. The He I absorption lines at 4471, 4026, 3964 were strong and sharp, and O II absorption rather faint. During the rise to maxima at August 24 and October 7, the magnitudes on these dates being $m_{pv}=2{\cdot}20$, $m_p=2{\cdot}06$, $m_{pv}=2{\cdot}05$, $m_p=2{\cdot}06$ respectively, the *H* central absorption became fainter and the 'dish-shaped' absorption stronger. The He I lines became fainter and more diffuse, OII became a little stronger, and λ 3888 (He I) very strong.

It was found that the colour index changes were subject to considerable uncertainty and did not show such pronounced correlation with spectrum changes as the magnitude variations. The mean colour index over the whole period was $-0{\cdot}12$, and corresponds to the average colour index of *B*6 stars. As γ Cassiopeiæ is a *B*2 star, the average colour index of which is $-0{\cdot}30$, its average colour index suggests considerable reddening.

ULTRA-SHORT RADIO WAVE PROPAGATION

AT a meeting of the Wireless Section of the Institution of Electrical Engineers on November 4, Dr. R. L. Smith-Rose and Miss A. C. Stickland read a paper describing the results of an analysis of field intensity measurements obtained during the years 1937–39, over the Post Office radio-telephone link between Guernsey and Chaldon, England, on wave-lengths of 5 and 8 m. (frequencies 60 and 37·5 mc./s.). The path between the radio stations was almost entirely over sea and about 85 miles in length, of which some 36 miles were outside the optical range. The material analysed was in the form of continuous, twenty-four hours a day, records of the field intensity received at Chaldon from the transmitters at Guernsey.

A quantitative study of the records confirmed the similarity of the type of signal fading on the two wave-lengths, and the lack of both diurnal and true annual variation; on the other hand, the results suggested a long-term secular variation in which the amount of fading on 5 m. tended to increase to a maximum over the period of observations while that on 8 m. decreased. The period of two years over which the observations were taken was not sufficient, however, to allow of any conclusions being formed as to an explanation of this trend.

Comparison with meteorological data showed a marked correlation between periods of very little fading and the presence of low-pressure systems, while periods of slow fading recurred at times of anticyclonic conditions. This, together with the fact that fading, while always less in winter than in summer, showed no regular seasonal variation, led to the conclusion that the winter decrease was due to the greater prevalence of low-pressure systems during this season.

A simple theoretical treatment of the propagation of waves through the lower atmosphere shows that account must be taken of the various paths by which rays can pass from transmitter to receiver, these rays being subject to diffraction, refraction or reflection on the way. The received signal is the resultant of the various rays received, and it is clear that interference effects may result from the arrival of two rays simultaneously by different paths. Sudden changes in the temperature and water vapour content in the atmosphere produce corresponding changes in refractive index and so cause marked bending of the rays transmitted. In regions of temperature inversion these conditions may be specially marked, resulting in the ray being completely bent over and returned to earth in a manner analogous to reflexion from a discontinuity.

An explanation of the lack of fading in bad weather and of the pronounced fading in good weather is sought in the fact that, in anticyclonic conditions, temperature inversions and associated sudden changes in relative humidity are usually present at heights of 1–2 miles, whereas in cyclonic or depression conditions these are absent. While the existence and diurnal variations of temperature inversions may be different over land and over sea, the general structure of the atmosphere in an anticyclone is probably the same in the two cases; in particular, changes in water vapour content may obtain over sea, which give rise to refraction in the lowest layers, and thus cause sufficient bending of the direct rays to account for the received signal and its variations. As mentioned above, rapid fading occurred mainly on the wave-length of 5 m. and was usually superposed on flat or steady records and was present only in winter. It is thought that this is probably a shimmering effect due to turbulence in the atmosphere during bad weather. A similar effect had previously been noted by Ross Hull in the United States and was attributed to the same cause.

A more detailed study of the radio phenomena on the above lines has not been possible on account of the limitations imposed by the nature of the meteorological information available at the place and for the period of the wireless observations. In future investigations, this limitation may be at least partly removed, by improved meteorological technique for studying conditions in the lower atmosphere, and by making arrangements for special and close co-operation between those responsible for the wireless and meteorological observations.

FORTHCOMING EVENTS

Monday, January 4—Wednesday, January 6

AGRICULTURAL EDUCATION ASSOCIATION (at the Midland Agricultural College, Sutton Bonington, Loughborough). Conference.

Monday, January 4

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP, PLASTICS GROUP AND LONDON SECTION) (in the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. K. Rideal, F.R.S.: "Catalytic Hydrogenation" (Jubilee Memorial Lecture).

Friday, January 8

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. C. C. Pounder: "Some Types of Propelling Machinery available to Shipowners" (Thomas Lowe Gray Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. C. Le Maistre: "War-Time Standardization".

Saturday, January 9

ASSOCIATION OF SCIENTIFIC WORKERS (in the Lecture Theatre o the London School of Hygiene, Keppel Street, London, W.C.1), a 2.15 p.m.—Conference on Problems connected with the Organisatio Application and Personnel of the Medical Sciences. (Chairman: D D. McClean.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or be fore the dates mentioned:

LECTURER IN MECHANICAL ENGINEERING—The Principal, Heriot Watt College, Edinburgh (January 7).

ASSISTANT TO THE ADVISORY OFFICER IN ANIMAL HUSBANDRY—The Secretary, West of Scotland Agricultural College, 6 Blythswoo Square, Glasgow (January 8).

WOMAN PSYCHOLOGIST for service at the Child Guidance Clinic—The Chief Education Officer, Education Office, Council House, Margare Street, Birmingham 3 (January 9).

REGIUS PROFESSOR OF GEOLOGY at Edinburgh University—Th Private Secretary, Scottish Office, Fielden House, 10 Great Colleg Street, London, S.W.1 (January 11).

SCIENCE GRADUATE (BOTANY), with experience in abstracting an knowledge of languages desirable—The Deputy Director, Imperia Bureau of Plant Breeding and Genetics, Cambridge (January 16).

RUSSIAN TRANSLATOR to work on literature in Agricultural Botan —The Deputy Director, Imperial Bureau of Plant Breeding an Genetics, Cambridge (January 16).

HONOURS GRADUATE TO TEACH BIOLOGY in the Bede Collegiat Girls' School—The Director of Education, 15 John Street, Sunderlan (January 18).

LABORATORY STEWARD for the Veterinary Laboratory—Th Veterinary Investigation Officer, University College of North Wale Bangor (January 18).

THREE JUNIOR ELECTRICAL INSPECTORS OF MINES—The Ministr of Labour and National Service, Central (Technical and Scientific Register (Section D.521), Sardinia Street, Kingsway, London, W.C.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Why India? By Reginald Reynolds. Pp. 28. (London: Wa Resisters' International.) *6d.* [211

Gas Research Board. Communication GRB7a: 33rd Report o the Refractory Materials Joint Committee. Abridged edition. Pp. (London: Gas Research Board.) [211

Institution of Gas Engineers. Communication No. 249: Repo of the Committee of Enquiry on Gas Quality. Pp. 10. Communicatio No. 250: Report of the Committee of Enquiry on Sulphur Remova Pp. 10. Communication No. 251: Report of the Committee of Enquir on Standardization of Appliances, Part 1: Domestic Gas Cooker Pp. 16. Communication No. 252: Report of the Committee of Enquir on Coke Quality, Part 1: Sizing of Coke. Pp. 8. Communication N 253: 3rd Report of the Chairmen's Technical Committee, 1941–42 Pp. 18. Communication No. 254: 19th Report of the Gas Educatio Committee, 1941–42. Pp. 24. (London: Institution of Ga Engineers.) [211

Other Countries

U.S. Department of Agriculture. Technical Bulletin No. 828 Further Studies on the Removal of Spray Residues from Easter Grown Apples. By M. H. Haller, C. C. Cassil, Edwin Gould and A. Schraeder. Pp. 32. (Washington, D.C.: Government Printin Office.) [211

British Honduras. Abridged Report of the Forest Department f the Year ended 31st December 1941. Pp. 4. (Belize: Forest De partment.) [211

Forest Research Institute, Dehra Dun. Indian Forest Leaflet N 22: Possible War-Time Sources of Vegetable Rubber in India. B T. V. Dent. Pp. iv+16. 4 annas; 6d. Indian Forest Leaflet No. 26 Rectangular Plywood Containers. Pp. ii+2+1 plate. 4 annas; 6 Indian Forest Leaflet No. 27: Notes on some Aspects of Erosi Control. By Jagdamba Prasad. Pp. v+18. 4 annas; *6d.* (Deh Dun: Forest Research Institute.) [221

University of Bombay: Department of Chemical Technolog Annual Report, 1941–42. Pp. iv+28. (Bombay: The Unive sity.) [221

Smithsonian Miscellaneous Collections. Vol. 103, No. 5: Ne Upper Cambrian Trilobites. By Charles E. Resser. (Publication 3693 Pp. iii+136. (Washington, D.C.: Smithsonian Institution.) [241

Annual Report of the Agricultural Department, Dominica, 19 Pp. 4. (Roseau: Agricultural Department.) [241

Catalogues

A Catalogue of Books and Periodicals on Entomology, together wi a Selection of Recently Acquired Books on General Natural Histo (No. 606.) Pp. 24. (London: Bernard Quaritch, Ltd.)

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RECONSTRUCTION AND SOCIAL SECURITY

THE full significance of the Beveridge report is only becoming apparent as its place in general reconstruction policies is appreciated. Already the report has brought the phrase 'freedom from want' out of the abstract into the concrete, and in doing so, as an article in the American periodical *Fortune* shows, makes a contribution to Anglo-American solidarity that should not be underrated. "We believe that it is possible, and therefore desirable, for the Government to set a minimum below which employment and the national income will not be permitted to fall. . . . Such a policy would in effect guarantee the existence of a job for every man who wants and is able to work. We do not think that the American voter will settle for less, and we see no reason why he should be asked to."

In the conditions or assumptions upon which Sir William Beveridge bases his Plan for Social Security, its linking with an all-embracing public health service and a national and international policy to maintain employment, he is clearly in line with tendencies in the United States which were foreshadowed in President Roosevelt's speech on "The Four Freedoms" two years ago, as the reception of the Plan outside Great Britain testifies. Already the report has put into our hands a weapon for political warfare of the first importance, when once the Government has recognized the opportunity and matched it with a series of social measures such as would restore the faith of the ordinary man throughout the world in the power of democracy to answer the imperious needs of a new age.

The exigencies of the war situation are therefore a reason not for delay but for action on the report. Sir William Beveridge, in the closing passage of his report, urges the importance of his proposals, or other proposals covering the same ground, as an aid to victory. His prescience has been brilliantly vindicated by the reception of the report abroad, the universal recognition of the connexion between the Beveridge Plan and the Atlantic Charter, and the acceptance of the report as a concrete effort to apply our principles and give a lead in building a world for the greater happiness of the ordinary man. There may be modification in detail, but there can now be no casting aside of the report without breaking faith. Action is imperative, and while it is right that there should be full deliberation over the proposals, procrastination would be a peril to the common cause as well as to ourselves.

Emphatically the first need is for decision as to the acceptance of the principles involved. This is the first step to be taken, before the detail of preparing the necessary legislation and bringing the scheme into being ready for the end of the War can be undertaken by some person or body appointed for that purpose. Decisions as to the rates of benefit and contribution can be left until the probable level of prices after the War is better known.

What is true in this question of the prevention of want is no less true of other aspects of reconstruction.

The prevention of want and the prevention of idleness, as Sir William Beveridge emphasized in his lecture to the Fabian Society, are distinct problems, needing distinct solutions. None the less, they are related problems, and the Beveridge report has the further merit that it places the whole question of reconstruction in its right perspective and calls for action all along the line in the attack on the five giant evils of physical want; of disease, which often causes want and brings other troubles in its train; of ignorance, which no democracy can afford among its citizens; of squalor, which arises mainly through the haphazard distribution of industry and population; and of idleness, which destroys wealth and corrupts men. Statement of a reconstruction policy by a nation at war is statement of the uses to which that nation means to put victory, when victory is achieved. In a war which many nations must wage together as whole-hearted allies, if they are to win victory, such a statement of the uses of victory may be vital.

Sir William Jowitt's speech, like that of Mr. Eden, in the recent two-day debate in the House of Commons on reconstruction, afforded some further evidence that the Government has fully in mind the wide range of problems involved, but the debate was chiefly of interest for its indication of a general sense that it is high time for general discussion to crystallize in terms of policy. Mr. Attlee has since affirmed the Government's resolve not to return to a scarcity economy, but to base policy on the utilization of abundance, and, in particular, has pledged the Government to an attack on the four great problems of unemployment, housing, social security and education, in the last of which, he said, investigations have reached an advanced stage. What is required, however, is decision on questions that determine policy. Of some of the vast territories on the map of the future which Sir William Jowitt and Mr. Eden endeavoured to unfold in response to Mr. Greenwood's appeal, a few, like those covered by the Barlow, the Beveridge, the Scott and the Uthwatt reports, have been fully explored. Others are now being explored by committees more or less well qualified and more or less adequately equipped. The recommendation of the Beveridge report for a further immediate investigation of the finance and organization of medical services with a view to the establishment of a comprehensive health and rehabilitation service is an example of other fields as yet marked out only in the broadest outline. The urgent need everywhere is to press forward the work of inquiry and, where this has been completed, for the Government to take clear and authoritative decisions of policy.

It is at this point that the Government's inaction is disquieting. The announcement of a new Ministry of Town and Country Planning is a decision to create machinery, not a decision of policy, and ill conceals a reluctance to reach a decision on the most important recommendations of the Uthwatt and the Scott Committees and the Barlow Commission. Again, there is a hesitant note about recent pronouncements on education, which the decision practically to suspend arts courses in the universities of Great Britain will emphasize. Further, the Beveridge report removes the last reason for delaying a decision on family allowances.

First among the decisions of principle now or soon required from the Government are clearly those on physical reconstruction and development of rural and urban Britain, on the integration of social services, and on education. In regard to these, it may well be argued as further reason for urgency that, though there may be division of opinion as to method, there can be little as to objectives. There is vital work to be done on which there is no controversy on Party lines. Whole towns, for example, must be reconstructed because the enemy has left no option, civic life has to be restored and strengthened, and the mobilization of peaceful industry to be achieved with the demobilization of the defence forces and war industries. These are obligations laid upon us by the impact of war, and they will summon for their discharge a spirit of public service which is the pride of all Parties and the monopoly of none.

The failure to implement sound planning on the lines lucidly and cogently recommended by impartial experts of unimpeachable qualifications, as in the Uthwatt report, or to allow them to be whittled down by the mere fear of action on a scale commensurate with the need, is to miss a great opportunity. Every social advance entails, and always has entailed, an adjustment of private interests to the requirements of public interest.

The interdependence of domestic and external policies, though it must be kept carefully in mind, for freedom from want cannot be achieved in isolation, either from attack on the other problems emphasized by Sir William Beveridge, or from other nations, must not be an excuse for procrastination or indecision. A world economic survey in this field would assuredly yield valuable results in the assessment both of want and of available supplies, a matter in which the Allied Post-War Requirements Bureau is only covering a part of the field. There need, however, be no delay in taking the decisions on policy and the establishment of the machinery and the preparation of legislation while the final facts determining the level of need and contribution are being ascertained.

There can be no doubt as to the value of general confidence that the Government had effective plans for maintaining employment after the War, and would use all the powers of the State, so far as necessary, for that purpose. That confidence, as Sir William Beveridge rightly insists, would be in itself a major contribution to victory, and nothing could more surely engender that confidence than the demonstration in those fields where the exploratory work is complete that the Government is ready and determined to act. As Mr. Greenwood rightly observed, it is the Government's business to lead and to make proposals for the future which honourably fulfil, so far as within its power, the promises that have been made. There can be no sheltering behind a smoke-screen of non-controversy. The test must be, not whether proposals or policy are controversial, but whether they are necessary and desirable in the national interest.

It is true that there must be frank and balanced recognition of all the elements demanded in a collective national effort. The Social Security Plan, for example, may have repercussions on our export trade which must be considered, as was frankly recognized by Sir William in his notable address before the Fabian Society. Maintenance of employment, upon which the success of a social security scheme depends, is the most urgent, important and difficult of reconstruction problems. Methods of solving it must be agreed and settled during the War. The demobilization plans of the Government must include not merely dealing with the armed forces and converting the war industries to peace production, but also a great development of export trade to pay for the food and raw materials which used to come as payment of interest on our overseas investments and for our shipping services. National planning and direction in the use of our resources are also essential. Both capital and labour, as Sir William Jowitt emphasized, must be more fluid, and barriers of custom, trade union rights and property rights which hinder the use of national resources in the way most urgently needed must be abolished.

In the execution of the plan it will be vital to preserve initiative and enterprise. The practical problem is that of discovering how to combine the proved benefits of private enterprise at private risk in the past with the necessity of national planning in the aftermath of War. That problem can only be solved by thorough and impartial investigation, and we may well hope that it will not be neglected by the committee appointed to formulate detailed proposals on the organization of industry to which reference is made in the recent statement; "A National Policy for Industry". Moreover, any further extension of Government activity in the economic field clearly involves reconsideration of the machinery and methods of government, including both the central organization and the Civil Service. We must face the possibility that for new jobs we may require a new type of official and a new organization. Sir George Schuster suggested in the reconstruction debate that we may need to develop a new career of what might be termed industrial statesmanship. There are already great industrial organizations which provide places for men of this type, but men of like calibre and experience are required on the Government side, who understand industrial processes and trade and yet are in a position to see the tasks and problems from the point of view of the Government as representing the whole community. Sir William Beveridge's own suggestion was for an Economic General Staff.

The question of the democratic institutions by which the organizing power of the Government can be integrated with the driving force of individual enterprise is one of the fundamental problems that confront us, and none makes more searching demands on lucid and intrepid thinking. There can be no quarrel with Sir William Jowitt's statement that the Government is surveying industry by industry because the structure of industry will not fit into a common mould. Different methods of co-operation and control may well be developed for different industries, but while the exact methods by which Government control and planning are to be exercised for particular situations require investigation and consideration, it is imperative that there should proceed simultaneously on the Government side an overhaul of the whole machinery of Government, including not merely the structure, recruitment and adequacy of the Civil Service as an instrument of modern government, but also of the ministerial and cabinet responsibilities and relations which are involved.

Those wider and fundamental considerations, rather than departmental interests or sectional views, should determine the choice of the machinery to be used in planning; between, for example, the recommendations of the Barlow Commission and the Scott and Uthwatt Committees. That is the least satisfactory feature of Sir William Jowitt's announcement of the establishment of a Minister of Town and Country Planning. Such a Ministry may, it is true, develop ultimately into the wider Ministry required to ensure full co-ordination and the formulation and execution of an adequate national policy. There is, however, nothing to indicate that the decision is based on a full examination of the structure of the Government machine, rather than on a desire to gain time and meet an embarrassing demand for action, as the successive changes of policy in this matter of planning might suggest.

It is well that there should be no hasty steps which might prejudice the establishment of machinery and institutions best adapted to serve the needs of the whole nation, and to reconcile the virtues of freedom and initiative with the order and discipline inevitable in a measure of planning. There must be timing in our planning: education is only one sphere where this is all-important. Democracy cannot seize the full opportunities which the War has opened up without fundamental and constructive thinking on these issues. Meanwhile, however, there is plenty of room for action to secure the ground required for further advance, to prevent obstruction by sectional interests and privileges, and to work out the technical and administrative details of the measures required to give effect to a national policy aimed at securing freedom from want and from unemployment, a programme for health and education, and the elimination of the squalor which arises through haphazard distribution of industry and population or the waste and abuse of resources or amenities. Wide though the range of Sir William Jowitt's survey, welcome as may be his remarks on housing, welfare and nutrition, agriculture, forestry, water supply, electric power supply and education, he said little to indicate that the Government has reached the stage of decision and action. Words alone will no longer satisfy the country as to the Government's earnestness in the matter, or fulfil the hopes and expectations which the Beveridge report and the speeches of Government spokesmen both in Great Britain and in the United States have already aroused. There can now be no turning back. The Beveridge Plan is not the only one which points to courageous simplification with great savings in administrative costs and in efficiency at the centre. From scientific workers as from other members of the community comes the demand that the Government shall match both the opportunity and its own declarations with decisions and administrative and legislative acts worthy of the cause in which we contend. They would be as inspiring to the nation in its war effort as the implementing of a social security policy would assuredly be in giving strength and a renewed impetus to the cause of the United Nations.

NORTH-WEST AFRICAN PREHISTORY

The Prehistoric Archæology of North-West Africa
By Frederick R. Wulsin. (Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University.) Pp. xii + 173 + 12 plates. (Cambridge, Mass.: Peabody Museum, 1942.) 3 dollars.

THIS is a book some of us have been wanting for a long time. From the prehistorian's point of view, north-west Africa is an extremely interesting region, and until now information about it could only be obtained in 'bits and pieces', often in articles which were difficult to come by. It is true that the author does not pretend to have visited the area he deals with, still less to give the results of his own excavations in the field; but he has examined most of the available literature critically, and as a result has pieced together a consistent account of the whole subject. A certain school of thought has grown up recently which appears to consider that no publication can be of much worth which does not give the results of personal excavations and investigation in the field. Those who take this view perhaps forget that their own results will necessarily have to be utilized by future researchers in the same way as Mr. Wulsin has used his sources, and their findings similarly subjected to critical study.

That the final conclusions given in this book will be universally accepted in their entirety is, of course, unlikely—indeed there are a number of alterations which will probably have to be made—but none the less the whole collects together conveniently a mass of information and will form the basis for all future discussion on the prehistory of this area.

The opening chapter sets the stage for the ensuing work from its environmental point of view. The area is defined and the climate, both present and prehistoric, considered; and it is interesting to note that apparently there has been little climatic change since Roman times. There follows a chapter on the Lower Palæolithic sequence. Here the author seems to accept the possibility that some of the *coup de poing* industries found on the surface in this area could be of much later date than their equivalents in western Europe (p. 13). But surely it is not so much the similarity in the shape of tools, ranging from South Africa to western Europe, that matters, impressive as is this fact alone; the point is the similarity in the evolution of the industries in these far-flung areas. Yet such an evolution took place under diverse conditions, and different materials were used for fashioning the tools. Surely this similarity in the evolution of the industries argues for more or less of similarity in date. Should there have been any great time lag, the different conditions in the different areas would have given rise to different developments. Indeed it would seem to me that there must actually have been slow cultural interpenetrations—like the movements of molecules in a liquid—which helped to give rise to the uniform developments that we find.

The relationship between the Lower Palæolithic industries and the geological changes as shown by strand lines is next considered. Here the author accepts Vaufrey's conclusion that no pleistocene bridge existed across the Mediterranean. If this were really so, north-west Africa would certainly have been, as suggested, rather a backwater than a highway—though none the less interesting for that—and communication between Africa and Europe would, until later times, have been almost entirely through Syria. One ventures to wonder whether this question is quite certainly settled. The author's tentative dating of the Chellean to a Mindel-Riss interglacial phase is, I think, probably incorrect. The industry at El Hank on subsequent investigation appears to be mixed Chelleo-Acheulean, and it would surely seem more likely that the true Chellean is contemporary with the final stages of the 90 m. shore-line and thus Gunz-Mindel in age—a correlation which agrees with the results of investigations in the Somme valley.

In his chapter on industries and their variants, the author deals with the middle stone age which, as always in Africa, is difficult to pin down and presents a number of variations. I wonder whether it is wise to use the term Mousterian until it has been definitely proved that Neanderthal man lived in the region and made these industries? But this question involves a definition of the term Mousterian. Mr. Wulsin uncompromisingly classes the Aterian as a Mousterian with one new tool, the tanged point. Actually tanged points have been found in Mousterian levels both in Jersey and at La Ferrassie. But surely the true Aterian is more than that. Among other types occurring, what about the points with thinning flaking on their under surfaces? That the Aterian has middle stone age traditions is undoubted, but can one not see later stone age contacts present? Its date, anyway, would seem to be late middle stone age. A chapter on the Upper Palæolithic follows next. Here a distinction is made between the Capsian culture and the Oranian culture, which has a rather different distribution. Both develop into Neolithic industries. One of the troubles in this southern region is the lack of the distinctive and drastic climate changes which give rise farther north to clear-cut distinctions between the various cultures. In Africa a culture, and the fauna too, just tend to continue on and merge into the succeeding culture, even when this latter is really mainly due to migration from outside the region and not to simple evolution of the predecessor.

Mr. Wulsin, naturally, does not discuss the problem as to whether there is any cultural connexion to be seen between the early Upper Palæolithic of north-west Africa and the Perigordian of western France; this would have made an intriguing digression. In passing, one can note a misprint on p. 81, where the word Caspian appears instead of Capsian in the table. Chapters on the Neolithic and early historic periods follow. There is still, of course, much work to be done on the desert pottery. It is unfortunate that many of the results obtained by the Wellcome and the Mond investigators still remain to be published. A most interesting chapter (illustrated) on the rock-shelter art follows. The author seems to accept Vaufrey's view that the drawings are Neolithic. It would seem, however, probable that an earlier rock-shelter art existed in the region, and that some of the drawings belong to this earlier date and culture. The Grotte d'in-Ezzan lies outside the region under review, but the earliest paintings there do form a link between the earliest art in Southern Rhodesia and that of eastern Spain. The latter is certainly in part older than the Neolithic. Finally, there is an excellent résumé on the skeletal finds and a general conclusion. A useful appendix on the prehistoric mammals of Algeria is given, and an excellent bibliography concludes the work.

The whole volume is lucidly written and well got up and misprints are rare; indeed with the exception of the 'Caspian' for 'Capsian' already noted there are none which are immediately obvious. Mr. Wulsin has done an excellent piece of work which will notably lighten that of all future investigators of north-west African prehistory. M. C. BURKITT.

THE COUNTRYSIDE AS IT WAS

Country Ways

By Esther Meynell. Pp. v+152. (London: Chapman and Hall, Ltd., 1942.) 12*s*. 6*d*. net.

Field Fellowship

By H. J. Massingham. Pp. 192+16 plates. (London: Chapman and Hall, Ltd., 1942.) 8*s*. 6*d*. net.

ENGLAND was last swept by a wave of faith during the Victorian era. Men worshipped wholeheartedly at the shrine of progress and were so intent on their end that they scarcely had time to notice the means they were employing. Then came the great reaction against this boundless faith and optimism. Men could not help noticing the consequences of their work: the dark factory filled only with gloom, machinery and hands; the slums and the slag-heaps that littered the countryside; and the appalling intellectual poverty of the bulk of the population. The city dweller, seeking ways of overcoming these blots of civilization, looks forward to an era of light and airy factories and homes built of modern materials if need be, glass, modern alloys and brightly coloured plastics, with gas and electricity as sources of light, heat and power.

The literary country dweller tends to take the opposite view. Seeing the slum, the slag-heap, and the soulless factory, he longs for the time before these existed, the era of the medieval village, the wood fire and the village pump; the era in which change, if it came at all, came extremely slowly. Village life was hard but satisfying, devoid of doubt or change, where every good workman was a craftsman and extremely proud of his craftsmanship. There were no mere mechanical machine minders in those days nor any leisure for such passive occupations as cinema-going. These two books, in their different ways, both describe this way of life, both seeing the village through rose-tinted glasses.

Mrs. Meynell's book describes country life as it was, illustrating her story with well-chosen quotations from contemporary authors. She is unashamedly parochial—her countryside is Sussex—but the book gains in vividness by this rigid geographical limitation. She knows her authors well and quotes sympathetically from many hitherto neglected. It is one of the most charmingly written of country books, and will delight every lover of the countryside.

There are only a few statements to which exception can be taken on grounds of scientific accuracy. Her statement that "the principle of ploughing—which is the inversion of the soil—remains the same, however eagerly man seeks after many inventions" is certainly not valid in the semi-arid regions. The ploughs used in the Middle East, which probably antedate the European by several millennia, have no mouldboard and only break up the surface of the soil without inverting it. The cause of the dust bowls in America and elsewhere is in part due to the unfortunate use of the European instead of the Asiatic plough. It cannot be due, as she suggests, to the use of artificial fertilizers, which are not used there owing to lack of water.

Mr. Massingham's book is a collection of articles about various aspects of country life. The longest section gives an admirable account of village architecture, showing in detail how sensitive the village builder used to be to the inherent qualities of his local material, and how his buildings displayed these qualities. Then there is a very sympathetic essay on W. H. Hudson which does full justice to his memory.

In the remaining thirty-seven short articles Mr. Massingham is an unrepentant longer for the past. What seems to be wrong, he says, with English village life is that it has changed since the seventeenth and eighteenth centuries, and almost every change has been for the worse. He writes appreciatively and with knowledge about old customs and trades, and so scathingly about modern ones that he is not concerned too much with mere scientific accuracy. Thus he is very fond of wholemeal bread, and sees, to his dismay, that the inhabitants of his village eat, in peacetime, white bread baked from white flour that has been milled in a large roller-mill situated at a port. What easier than to accuse the big millers of encouraging people to want to eat white bread. Yet Drummond and Wilbraham pointed out in their book that people were clamouring for white bread a full century before the 'big business' miller and the roller mill. Parliament tried several times in the eighteenth century to make people buy a good nutritious standard loaf, but the clamour for white bread continued, though it was more expensive and the whiteness was often obtained by using alum and perhaps other adulterants.

The picture of the countryside to-morrow need not be so black as Mr. Massingham implies. Mechanization of agriculture means using machines to do work previously done by hand, but it does not necessarily mean cultivating 1,000 acres with 100 horse-power tractors. To-day the corn ranch can be mechanized, and there is no reason why a mixed dairy farm of 100 acres and small fields may not be as completely mechanized in the future, though the dairy herd could, and probably would, receive as much personal care as in the past.

Mr. Massingham naturally deplores the loss of ancient crafts in the villages that followed the introduction of the factory, but he seems to have overlooked the new crafts now being acquired. The village garage mechanic is often a superb craftsman, but he uses steel, the oxy-acetylene torch and the power-driven lathe instead of iron and the treadle lathe of his ancestors. But that makes him none the less as genuine a craftsman as the village carpenter, though his workshop may smell of oil rather than of wood shavings.

These two books serve the valuable purpose of emphasizing that village life had an unhurried simplicity and gave a contentment to its inhabitants that is frequently lacking at the present time. One of the great problems for the future is to fuse this essential completeness of village life with the intellectual ferment so characteristic of the present time. Few would willingly wish to retain the intellectual stagnation that was too often a characteristic of village life in the past.

E. W. RUSSELL.

FOUNDATIONS OF ASTRONOMY

Foundations of Astronomy

By Prof. W. M. Smart. Pp. vii+268. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1942.) 16*s.* net.

PROF. W. M. SMART needs no introduction as a writer of astronomical books. These range from popular accounts such as "The Sun, the Stars and the Universe" to his valuable and comprehensive work "Stellar Dynamics", dealing with the movements of the stars.

The work now under review falls in the gap between popular descriptions of astronomy and general text-books for university students, such as the standard "Text-book on Spherical Astronomy" by the same author, now in its second edition. "Foundations of Astronomy" is intended for students taking a first-year course in astronomy in the universities and for all those interested in the subject who feel the need for a more solid foundation than the many descriptive books can provide. The author hopes also that the book will be of value to the many young men in the naval and air forces, who are required to have some knowledge of astronomy in its application to navigation as an introduction to the Service manuals in which greater emphasis is laid on technical matters.

Commencing with chapters on "The Geometry of the Sphere" and "The Celestial Sphere", the book gives definitions of most of the astronomical terms, accompanied by full and careful explanations, which will be found simple to follow, and by illustrative examples. A prominent feature in these explanations is the use of appropriate diagrams, well thought out and produced. Along with these definitions there occur many descriptions and explanations of natural phenomena which will be found illuminating. It is worth noting that the spherical trigonometry used is made to depend on one formula only—the cosine formula—and that this dependence is direct in each case.

Although the astronomy is mainly positional, the chapter on "The Stars" includes a brief introduction to the spectrum and to some of the important and fascinating results which may be obtained by studying the constitution of the light from the stars. A chapter on the "Determination of Position on the Earth" is also included.

A useful feature is the inclusion of a number of examples for the student at the end of nearly every chapter, together with a collection of answers at the end of the book. Appendixes give tables of astronomical constants and the elements of the planets and the satellites, and the book possesses a useful index.

The work is beautifully printed and shows very little evidence of war-time production.

A few minor misprints and obscurities have been noted, but only one seems likely to cause confusion; in section 138, on the "Heights of Lunar Mountains", it should be noted that only a particular case is concerned, when M is on, or very near, the moon's equator (incidentally, Y is not a cusp).

"Foundations of Astronomy" as a whole gives a simple and adequate account of astronomical terms and usage; further, it is at the same time just a little more than a bare text-book in that it describes rather more phenomena than are needed to explain the definitions. The mathematical attainments of the student are carefully considered, as is indicated by the use of asterisks to point out sections which may be omitted from a first reading, and by the very careful explanations, particularly in the more elementary parts—the true "Foundations".

J. C. P. MILLER.

DRAINAGE OF OIL WELLS

Oil Well Drainage

By Dr. Stanley C. Herold. Pp. xv+407. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1942.) 30*s.* net.

PETROLEUM technologists, especially on the production side, will be familiar with the author's "Analytical Principles of the Production of Oil, Gas and Water from Wells", published in 1928—a severely mathematical treatise of a complex subject. Reviewing that volume the writer stated at the time that it was "unquestionably a remarkable effort for one man and nothing quite like it has appeared before in the annals of petroleum literature". The same can be said of this, Dr. Herold's latest work. This time it is the story of oil well drainage shorn of mathematics (except in a brief appendix) but replete with recorded incidents and observations skilfully interpreted in terms of what is unseen in natural oil reservoirs. The basis of this work is primary analysis of any particular North American oilfield by reference to a questionnaire of twenty-one questions (introduction) to which appropriate answers, where they can be given, are collated and resulting data segregated according to whether the oilfield is Palæozoic or Cenozoic.

This division into "older" and "younger" constitutes a twofold classification governing considerations of reservoir energy; the function of natural gas; radius and area of drainage; regional drainage and water encroachment; drainage across property lines; effects of stratigraphy and structure on drainage; effects of reservoir penetration on drainage; effects of multiple zones on drainage; effects of rates of production on drainage; effects of field development on drainage; drainage by wells of all or no gas; injection of gas, water or oil; reservoir content, ultimate recovery and reserves; abandoned oil and gas; curtailment, proration and conservation.

There are always snags in any attempt at simplification of highly variable functions, especially of fluids like petroleum and natural gas. For example, oil wells drawing from Tertiary deposits may simulate Carboniferous or older formational types of production and *vice versa*. The admittedly rarer instances of Mesozoic oil may possess production characteristics of either Cenozoic or Palæozoic pools; the author apparently sees no reason to suspect a third type of production peculiar to Mesozoic formations, but he does not neglect such possibilities. Another interesting point: two types of production provide two types of drainage and, according to the author, where an oil well at any specified time of its life is producing exclusively to the pattern of one type of production, its reservoir is subject to only one corresponding type of drainage and there is no compromise between the two types. But conditions may alter within the reservoir when the well may change its production and drainage pattern from one type to the other.

This is admitted, but surely it does complicate the issue considerably; whether such change can always be detected from performance of the well or behaviour of reservoir, as suggested by the author, is a debatable point, especially, for example, in the case of production from multiple sand lenses embedded in clay, for example, Trinidad.

Although this book deals essentially with the physical features of production and drainage, the mathematical basis or proof for the theses submitted is constantly in the background and one feels that the period 1928–1941 has, by increased experience in many fields, served rather to confirm than to amend the author's earlier analytical results. In fact, in a delightful preface, he acknowledges James Perrin Smith's advice to him to tell the story "in simple language and do not fail to cite the field examples of drainage that you will have found". This has been done and done well, in a volume of some four hundred pages, thirty-six line diagrams of oil fields and relevant subjects heading the chapters, and in an easy, informal, conversational style that in no way detracts from the masterly grip Dr. Herold obviously has of a subject he has made very much his own.

Whether the profusion of small-type marginal notes throughout the text, plus the use of several different point sizes, including Gothic type captions, is intended as an artistic presentation of a subject that has few of the arts and most of the sciences, is doubtful and, in these days of austerity printing, the reader may think this has been rather overdone. But no one, not even "the operators, leaseholders, landowners, attorneys at law, legal experts on contracts, politicians and governmental agents", for whom the story is told in this way, can fail to derive a measure of contentment from its unfolding; to that list may well be added the "petroleum technologist", to whatever specialized branch he devotes his ability and learning.

H. B. Milner.

NON-SINGULAR CUBIC SURFACES

The Non-Singular Cubic Surfaces

A New Method of Investigation with Special Reference to Questions of Reality. By B. Segre. Pp. xi+180. (Oxford: Clarendon Press; London: Oxford University Press, 1942.) 15*s*. net.

This is a very remarkable monograph; it is a direct product of war circumstances. After a curt verification of the existence (Cayley, Salmon, 1849) of a symmetrical system of twenty-seven lines, each met by five pairs of mutually intersecting lines, the author turns to a diagrammatic representation of the lines, by the joining segments of nine points which lie in threes on three coplanar concurrent lines. This is reached by considering how the lines would vary in a continuous deformation of the surface into three planes, and, beautifully executed as they are, the various diagrams serve the author's purpose well. Actually, the representation is the dual of one considered by Bennett, in which the lines of the surface are represented by the points in which the rays of three coplanar pencils, α, β, γ, each of three rays, meet one another; in this representation a line of the (Steiner) system of nine lines, represented by the intersection of a ray b of the pencil β, with a ray c of the pencil γ, meets the four lines indicated by the intersections of the other rays of these two pencils, and meets the six lines indicated by the intersections of b and c with the rays of the pencil α. This law of intersection is unaltered by the interchange of the rays of a pencil among themselves, or by the interchange of the pencils.

It can be shown that there are forty ways of arranging the twenty-seven lines in such three associated Steiner systems, indicated by the intersections of three pencils of three rays. Thus there are 40×6^4, or 51,840, ways of arranging the twenty-seven lines among themselves so that all intersections persist. The *group* of operations which effect these arrangements is also obtained by the author by combining the thirty-six transpositions of the lines of the various double sixes; his discussion involves a masterly exposition of the relations among the lines. He shows, too, as Burnside had shown, that the group can be generated by combining only six such transpositions. He does not refer to Coxeter's conclusion that the group can be generated by combining one such transposition with a single cyclical change of nine tritangent planes, containing the lines of three associated Steiner systems.

In pursuance of his main object, the author next obtains the five Schläfli types of real surfaces, $F_1, \ldots, F_5$, with, respectively, 27, 15, 7, 3, 3 real lines (the last type consisting of two pieces). However, to study the groups of possible interchanges of the lines of these various types, many distinctions of character are considered for the lines. A real line is elliptic or hyperbolic, according as the involution on the line, arising from the tangent planes through it, has imaginary or real foci; and hyperbolic lines are of two kinds. An elliptic line is right- or left-handed according to the direction of rotation of the tangent plane through it, as the point of contact moves along the line. An imaginary line is (in von Staudt's phrase) of the first or second kind. All these, and other distinctions, must be preserved in the allowed exchanges of the real and complex lines of the surface, the aggregate of which constitutes the group. The result of a complicated discussion is that the respective orders of the groups of the real surfaces are 60, 36, 4, 24, 24.

After this the author proceeds to the consideration of the regions into which the real lines divide the surface. He computes, with an interesting examination of the shapes of the various regions, the number $r = 2 - \alpha_0 + \alpha_1 - \alpha_2$, wherein α_0 is the number of intersections, or corners, of the regions, α_1 is the number of segments, each terminated by two corners, and α_2 the number of regions; and finds the values of r for the respective types of real surfaces to be 7, 5, 3, 1, 1. A remark is possible in regard to these numbers: For the surfaces F_1, F_2, F_3, there exist double sixes of which one half consists, respectively, (1) of six real lines, (2) of four real lines and two conjugate complex lines, (3) of two real lines and two pairs of conjugate complex lines. If we compute the number r for a (projective) plane, using the joining lines of 6 (or 4, or 2) real points therein to determine the regions (with two other lines in the last case) we obtain $r=1$. But, if we make holes in the plane, bounded, say, by circles the centres of which are at the 6 (or 4, or 2) points considered, the values of r for the desiccated plane will be 7 (or 5, or 3). The suggestion of Cremona's representation of the cubic surface on a plane is obvious.

The last chapter of the volume, largely algebraical, is devoted to Sylvester's representation of the equation of the surface by the cubes of five linear functions. It is shown that there are two types only, of non-singular surfaces, which cannot be thus given by five (or fewer) cubes, but that these are given by six cubes. One type, with vanishing discriminant, requires seven cubes. The author also applies Sylvester's form to obtain the five types of real surfaces, distinguishing between them by inequalities among the coefficients multiplying the five cubes.

It will be seen from this skeleton survey that the book is one for which, for long years, the reader will be grateful to the author—and to the Clarendon Press. H. F. BAKER.

HIGH-SPEED COMPRESSION-IGNITION ENGINES

High-Speed Diesel Engines

With Special Reference to Automobile and Aircraft Types; an Elementary Textbook for Engineers, Students and Operators. By Arthur W. Judge. Fourth edition, revised and enlarged. Pp. vii+536+45 plates. (London: Chapman and Hall, Ltd., 1941.) 25*s*. net.

THAT a fourth edition of this book has been published only eight years after its first appearance shows that it meets a demand. The author has compiled a vast and valuable fund of information and has been very well supported in the presentation of this matter by the publishers. The greater is the regret that the author has not found it possible to reduce the number of errors and to avoid presenting, as in many instances, incorrect pictures of various aspects of his subject. To assist the student—and also the author in preparing a new edition—the following points are mentioned.

In the development of high-speed compression-ignition engines, extending over nearly twenty years, it is inevitable that many designs of combustion chamber and of injection equipment should be put forward and for various reasons afterwards dropped. In his preface, the author explains that he has retained many of these "in view of their historical interest". This would be well justified if he had indicated those designs that are obsolete and those which continue to be built; but the reader is left in complete ignorance on this distinction.

A similar vagueness surrounds many of the technical and experimental subjects treated by the author. Views of writers of scientific papers are often quoted or embodied in the text, the references and dates of the papers being usually quoted; but the value of these would be greatly enhanced, and a more accurate presentation given, if the author, after suitable analysis, had stated which of these had proved, in the light of later evidence, to be incomplete.

Some of the errors relating to combustion chambers are as follows: on p. 140, the statement appears that the Lanova combustion chamber was produced by the inventor of the Acro combustion chamber "acting in co-operation with F. Lang". This is misleading, but is nevertheless true, since Lang was the inventor of *both* combustion chambers. On pp. 143 and 144, reference is made to the Omo and the Oberhänsli combustion chambers, and the latter is said "to resemble the Omo". They are one and the same, the designer being the Swiss engineer, Oberhänsli, while the company controlling the commercial development is the Omo A.G., of Zurich. The M.W.M. design on p. 120 is given as a modified type of Acro combustion chamber: while it is similar, it was the result of independent development. A modification was, however, actually made by the Saurer company to the Acro design, by giving a 'cross-stream' motion to the air. The author attributes this modification to a designer, "Kreuzstrom" by name.

Contrary views are often given without suitable analysis, following the method of compilation adopted by the author. For example, the picture of the initiation of combustion presented on p. 94 differs from that on pp. 99 and 100. In discussing the influence of injection advance on ignition lag, on pp. 101 and 102, the author, near the bottom of p. 101, reaches the conclusion, given in italics: "the ignition lag will therefore be greater as the injection is advanced". On p. 102, he goes on to give the results of tests by Dicksee which, with one design of combustion chamber, confirm this and, with another, contradict this conclusion. This is followed by the correct conclusion that the result also depends on the combustion chamber; but this is not given in italics by the author, and a reader taking a cursory glance at the passage would be completely misled. If, however, the author had analysed the subject and had correlated the results with Bird's work in Fig. 53, or better with Wolfer's later work at Cambridge with Bird, which is not mentioned, a correct picture would have resulted.

On pp. 179 and 181, the author refers to the excellent pioneer work of Taylor and Hawkes at Farnborough, reported in Taylor's paper in 1927, and writes, with italics: "Another interesting point observed was that *as the torque was reduced, so was the specific fuel consumption*". Although slow-running compression-ignition engines had revealed such characteristics near full-load, this may have been a striking result in 1927 for a high-speed unit, but the author himself, notably in Figs. 15, 33, 263 and 297, shows that this has long been recognized as the normal characteristic of compression-ignition engines. This is a typical fault of compilation.

Errors and slips in references are numerous, and the following may be mentioned: p. 69, 1926 p. 555 for 1932, p. 685; Figs. 40 and 44 are obviously from the same reference but are not acknowledged; p. 36, 1831 for 1932; p. 169, 1931–32 for 1934, while Fig. 124 is from this reference but not acknowledged. 'Junkers' is usually given as 'Junker'.

Many of these are minor matters to those who have read widely in the subject; but in a work described on the title page as an elementary text-book for engineers, students and operators, they become of vital importance. Reference to the numerous original papers is difficult for such readers, and the responsibility of the author is great. It is to be hoped, therefore, that in the fifth edition which will certainly be called for, the author will convert his work from being merely good to superlative. S. J. DAVIES.

AN INTERNATIONAL ANTI-LOCUST CAMPAIGN

By Dr. B. P. UVAROV

Anti-Locust Research Centre,
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As an outcome of a series of intensive investigations carried out during 1930–38 by entomologists of several nations on a common plan, practical schemes for the preventive control of the three species of African locusts were formulated[1]; but the outbreak of the War in 1939 made the postponement of schemes, which were of necessity international in character, apparently inevitable.

Efforts to save the situation, however, were continued and full credit is due to the respective Governments for establishing two of the three projected organizations, although on a necessarily restricted scale. The organization for the control of the Red locust (*Nomadacris septemfasciata*), with headquarters at Abercorn, Northern Rhodesia, came into existence in 1940 and is now a joint British-Belgian undertaking. Its field work is progressing, and regular patrolling of the outbreak areas has already been organized.

The original outbreak areas of the African Migratory locust (*Locusta migratoria migratorioides*) are on the middle Niger in the French Sudan. Since swarms of this locust, if allowed to spread, would overrun the greater part of the African continent, the organization for the prevention of its outbreaks was planned as a French one, but supported financially by all the countries concerned. The isolation of French West Africa made the fate of this plan very uncertain, and considerable anxiety was felt in other countries of Africa that a new outbreak of the Migratory locust might develop on the Niger unchecked. It was, therefore, welcome news to learn that a "Centre du surveillance antiacridien" has been established on the Niger, as a purely French organization, though its work is certain to benefit a number of other countries.

No details are available as to whether the organization is sufficiently strong and extensive to cope with any emergency; but in any event its existence means that the beginning of the outbreak will not pass unnoticed. In fact, reports have come through that some signs of renewed activity of the Migratory locust were observed last spring on the Niger, but that the first incipient swarms have been destroyed. In view of this news, an effective strengthening of the French organization would be in the direct interest of the whole of West Africa, Equatorial Africa, Belgian Congo and all East African countries from the Anglo-Egyptian Sudan down to Southern Rhodesia, Mozambique and Angola.

The third species, the Desert locust (*Schistocerca gregaria*), presents the greatest difficulty from the point of view of its preventive control. The western region of its invasions comprises the drier zones of West Africa, Morocco, Algeria and Tunisia, and the investigation of its outbreak areas in that region had not been completed when a new invasion commenced in 1940; at present the invasion is fully developed and requires measures for direct control of swarms on a large scale. The eastern region of the Desert locust extends from India, through Persia and Arabia into Eastern Africa and the Sudan. Some of the original outbreak areas here have been discovered, and an organization for their preventive control should have come into operation in 1939–40, but the proximity of the war zone made this impossible. As a result, the first swarms had a chance to develop unchecked, and at present the Middle East, India and East Africa are faced with the prospect of repeated invasions during the next two to three years. The production of food and fodder is of considerable importance to the Allied war effort, since local shortage would have to be replaced by importation, with consequent extra demands on shipping space. Hence an anti-locust campaign had to be organized throughout the threatened countries.

Studies on the seasonal migrations of the Desert locust, carried out by the Anti-Locust Research Centre during the last twelve years, have shown that the whole region from India to East Africa forms an interconnected migration area. Swarms bred during summer monsoon rains in India move in the autumn to southern Persia and Arabia; the latter country receives at the same time swarms bred during the summer monsoon in Africa. Some of the invaders breed in southern Persia and Arabia, and in the following spring swarms move to the borders of Soviet Middle Asia, into Iraq, Transjordan, Palestine, Syria, Sinai and Egypt, where a spring generation is produced; later in the season there is a dispersal of swarms westwards to East Africa and eastwards to India for subsequent breeding in the summer monsoon rains.

The existence of such extensive movements of swarms makes it futile for each country to attempt its own isolated control operations, as has been the practice in the past, when a united anti-locust policy had little chance against the isolationist tendencies. Paradoxically, war conditions have removed many difficulties and have made it possible to organize, not a dozen small campaigns aimed merely at the defence of crops in each country, but the development of a single plan embracing all the countries involved and assuming the character of offensive operations. The plan aims at the extermination of locust swarms not only where they represent an immediate danger, but also in the desert areas where they may be harmless locally but represent a potential threat to other countries.

A campaign of this kind should be based on exact and timely information with regard to the movements of swarms, and special efforts have been made to improve and enlarge the existing locust information service. The present conditions have made possible its extension to areas which used to be inaccessible, so that now the developments in the whole region can be fitted into a single picture on which forecasts of expected movements can be based. It is a point worth mentioning that, during the present locust outbreak, no country has been invaded without receiving a timely warning from the Anti-Locust Research Centre, whereas in the past the invasions happened unexpectedly and defence measures had to be improvised in haste, with disastrous consequences.

In planning the campaign it was necessary, first of all, to take into account that in several of the countries concerned there exist efficient local entomological organizations. Such organizations in Egypt, Palestine, the Sudan and Kenya have undertaken to act as local centres for collecting information, while they also render great services to all surrounding countries by the preparation of poison bait and by the training of native technical personnel. The Anglo-Egyptian Sudan, with its model anti-locust organization, has naturally become a most important base and a training ground, not only for the technical staff who are sent to the 'locust control school' from other countries, but also for the newly appointed locust entomologists.

The second group of countries comprised those with anti-locust organizations of their own, but with resources insufficient for large-scale operations. War conditions have made it difficult to obtain, for example, poison for baits, and supplies had to be acquired in bulk and distributed where they were needed, while reserve stocks were laid down at conveniently situated bases. In the case of Persia, outside assistance with regard to supplies, however, did not solve the difficulty. Southern Persia was expected to become this winter an important, probably even the main, concentration area of swarms, and this forecast is being fulfilled. The local Persian entomological organization would be adequate in a normal year, but it was clearly impossible to expect it to deal unaided with the present emergency. Moreover, the immediate importance of locusts in the sparsely populated and little cultivated areas of southern Persia is much less than their threat to India, Soviet Middle Asia and the whole of the Middle East where they may spread next spring. On the other hand, such concentrations of swarms throughout the winter and subsequent breeding in early spring make southern Persia a convenient ground for large-scale operations designed to reduce the number of swarms available for invasions. These considerations led to the organization of a joint campaign in which Persian, British, Soviet and Indian experts are working side by side according to a single plan and pooling their resources.

Finally, there are some countries where there exist no organizations capable of undertaking locust operations. To leave them out would mean creating sanctuaries for locusts where they would breed undisturbed and then move in vastly increased numbers to more fertile regions. In this respect, the vast peninsula of Arabia represents a problem in itself. It has been established that over-wintering of swarms and their breeding in early spring occur in Arabia on a large scale, but that in late spring practically the whole peninsula is evacuated by swarms which spread to the surrounding countries, including eastern Africa. From the local point of view, locusts are scarcely of any economic importance, the population being largely nomadic, but the interests of other countries demanded the inclusion of Arabia in the general plan of campaign. The only part of the peninsula where operations could be organized by the local Government is Aden and its protectorates, where some assistance was needed only as regards supplies and technical personnel. Elsewhere, everything must be done by special motorized parties led by experts. Again, as in Persia, the collaboration of several countries has made this possible, and a plan has been prepared according to which several of the most suspected areas will be covered by the British, Egyptian and Indian parties. Very scanty information with regard to the interior of Arabia and obvious difficulties of work in such a country make this part of the campaign somewhat hazardous, but even if the immediate practical success is incomplete, valuable experience will be obtained for use in the next campaigns.

Ethiopia required special treatment. Owing to its geographical position it plays an important, but still very imperfectly understood, part in the seasonal migrations of locusts. Practically no data on this subject were available before the Italian occupation, and the short period of Italian rule coincided with the clear interval between the two outbreaks of the Desert locust. Therefore, it was essential, from the general point of view, both to ensure that the breeding of locusts and the movement of swarms in Ethiopia should not remain unknown, and to endeavour to introduce modern control methods into local use. A special anti-locust mission has been sent to Ethiopia, and its first aim is to create an efficient locust information service, as well as to demonstrate modern methods of control, and to train local technical personnel which may form the nucleus of an Ethiopian anti-locust organization. The work of the mission is proceeding with a considerable measure of success, and this large and important blank in the maps of locust movements in Eastern Africa is now being filled.

Such are the scope and the aims of the present anti-locust campaign in the Middle East and East Africa. Its general direction, requiring the close collaboration of many Government Departments, is in the hands of an Interdepartmental Committee on Locust Control at the Colonial Office, while the technical and the scientific side, including the planning of operations, is directed by the Anti-Locust Research Centre, under Sir Guy Marshall. The British experts who have been specially engaged for the liaison work between different countries and for directly conducting operations where this is required, form a Middle East Anti-Locust Unit, attached to the Middle East Supply Centre, which makes the necessary administrative arrangements for the provision of transport, the procuring of supplies, their distribution, etc.

With the campaign still in its initial stages, it may be too early to say whether the organization just outlined will prove to be adequate to meet the situation, which is certain to become increasingly serious. However, preparations have been made while the outbreak is only developing, and the first season should show whether any modifications are needed to meet the peak of the outbreak expected to be reached in 1943–44.

In these times, when the possibilities of planned application of scientific knowledge on a scale unrestricted by national considerations are attracting general attention, the present anti-locust campaign may constitute a useful test case. Four features of the campaign should be of general interest. First, the campaign has assumed its international scope quite naturally, because the situation could not have been dealt with efficiently on a narrow national basis. Secondly, the co-operation of the various countries concerned was obtained without difficulty, because their self-interests coincided with the common interest. Thirdly, the necessary unity of operations was achieved not by attempting to introduce a rigid central direction, which would inevitably cause friction, but by offering the co-operating countries a definite practical plan based on a sound scientific foundation. Finally, the whole organization is kept together by the demands of the work in hand rather than by formal agreements, and this makes it very flexible and easily adjusted to meet changing conditions.

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[1] NATURE, 142, 174 (1938).

THE INTERFEROMETER IN LENS AND PRISM MANUFACTURE*

By F. TWYMAN, F.R.S.

THE optical system used by Michelson in his interferometer, which was applied by him to so many important purposes, has since 1917 been gradually coming into use in a modified form as a routine test in the manufacture of lenses and prisms. The various forms in which it has been used have been the subject of a series of patent applications[1] and have been described in various technical papers[2], which are of little interest except to specialists in optical manufacture. The general principles of the instrument may appeal to a wider circle and are sufficiently well illustrated by the two simplest forms called, respectively, the prism and the lens interferometer.

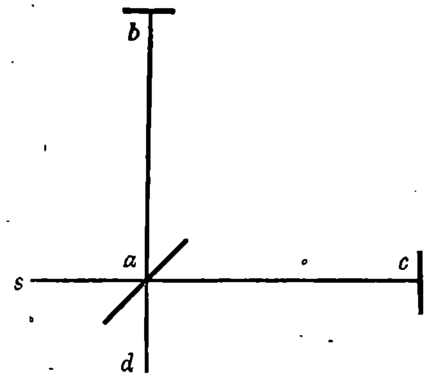

Fig. 1.

All the forms are based on the system of mirrors illustrated in the paper by Michelson and Morley (*Phil. Mag.*, 1887) and shown in Fig. 1. The effect of this system of mirrors is optically almost identical with the process of putting two flat glass plates together face to face to form Newton's colours. These are formed by interference of the light reflected from the two opposing surfaces, and are the same in their nature as the Newton's rings which are caused when a shallow convex glass surface is laid on a flat one. This ring system was described by Newton ("Opticks", Book 2), who was the first to find a relation between such colours and the corresponding distances apart of the surfaces.

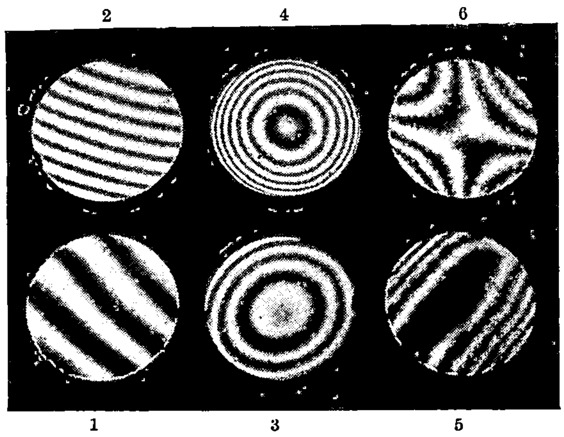

Fig. 2. APPEARANCES WITH PROOF PLATE.

1. Nearly perfect, the proof plate slightly tilted.
2. The same, but the proof plate tilted about 2½ times as much.
3. Astigmatic surface (slightly ellipsoidal).
4. Surface concave or convex, according to the colours.
5. Strongly astigmatic.
6. Astigmatic of the saddle-shaped variety, that is, concave in one direction, convex in the direction at right angles.

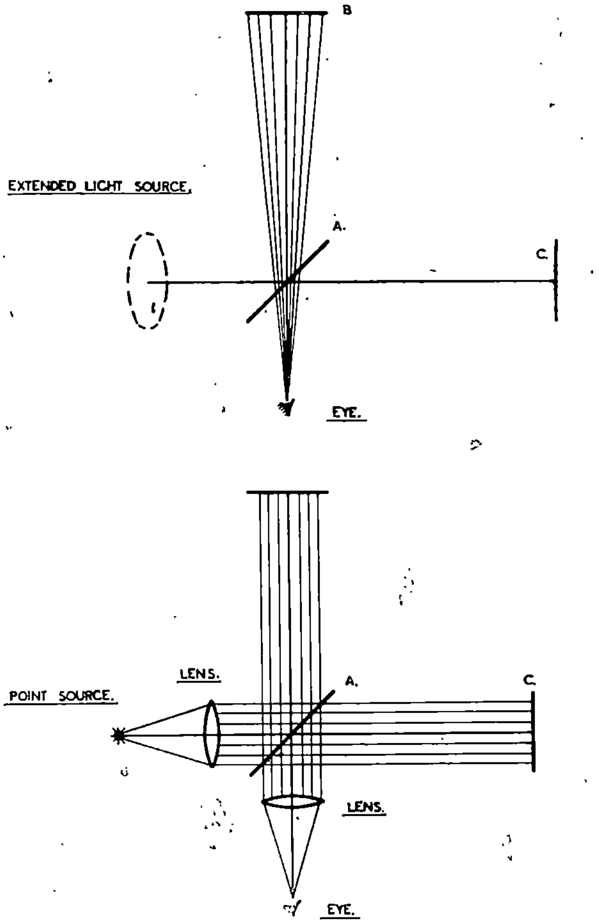

Fig. 3. DIAGRAMS OF MICHELSON (ABOVE) AND TWYMAN AND GREEN (LOWER) ARRANGEMENT.

Newton's bands have, of course, been utilized for many years, possibly for more than a century, in optical workshops, by the use of the optical proof plate. The optician has one surface which he calls the proof plate and on which he can rely as being of a standard flatness or sphericity, and he tests the flat or curved surfaces which he is making by putting the proof plate in contact with the work. Fig. 2 shows some of the appearances which may be observed.

Referring now to Fig. 1: *sa* is a ray of light which is partly reflected from *a* to *b* and partly transmitted from *a* to *c*, the mirror *a* being lightly silvered. If the paths *ab* and *ac* are equal, an image of *b* is formed in contact with *c*, and we have the conditions optically identical with those producing the Newton's colours when two plates are placed in contact. If the position of the mirror *b* is gradually altered we shall reproduce the optical effect of separating two such plates.

In the Twyman and Green prism and lens interferometers, the Michelson mirror arrangement is modified as shown in the lower part of Fig. 3. It will be seen that in the Michelson arrangement the

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* From a discourse at the Royal Institution on November 27.

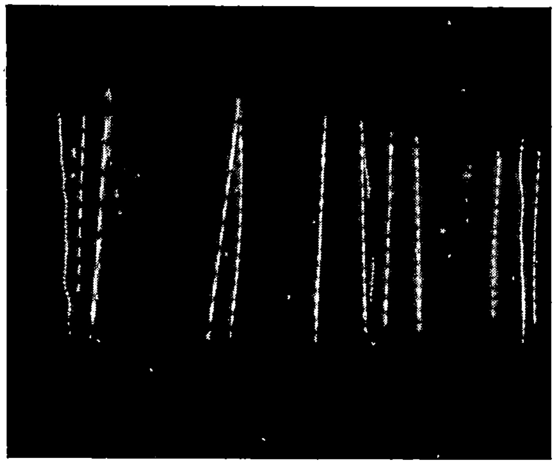

Fig. 4. FALL OF DUST PARTICLES.

rays which reach the eye come from the mirrors at various angles. An extended light source must be used otherwise only a small part of the field of view would be illuminated. If one of the plates is moved in a direction perpendicular to itself, one gets a system of rings exactly like the Newton's rings, which are seen when one separates two glass plates, while maintaining them parallel to one another and observing them at normal incidence. In the Twyman and Green arrangement of mirrors a point source is used and the spherical wave front proceeding from this is collimated to form an approximately plane wave front and so proceeds to the mirror system. On reaching the second lens it is once more converted into a spherical wave front converging upon the eye. The rays which reach the eye, therefore, have traversed the system parallel to each other, or to speak in the language of the wave theory of light, the beam of light traverses the mirror system with a plane wave front.

One part of the Michelson system has been omitted in these figures—a plate of glass of exactly the same thickness as that of the diagonal mirror. This is not necessary in the Twyman and Green instruments as used in the optical workshop, since monochromatic light is used, the light being obtained from a low-pressure mercury vapour lamp.

The simplest application of this instrument is to use it instead of a proof plate for testing the flatness of optical surfaces. To do this the mirror *c* is replaced by the object the polished surface of which it is desired to test; for that purpose the surface must be placed on a levelling table, and on adjusting the instrument, one then sees a contour map representing the imperfections of the polished surface, it being presumed that the mirrors are optically perfect. It may be asked, why use so complicated an apparatus when we could just as well use a proof plate? There are two objections to the use of proof plates: one is that particles of dust are always settling on the surfaces to be tested, so that no matter how carefully one cleans them there is a risk of grit being present between the proof plane and the surface to be tested. These prevent the surfaces coming close enough together to give brilliant Newton's fringes, and there is then an almost irresistible impulse on the part of the optician to attempt to force them together, with the inevitable result of causing scratches. It may be asked why, then, are precautions not taken to avoid such dust? This is not so easy. Fig. 4 is a photograph of falling particles of emery powder in still air. The particles are illuminated by a strong beam of light which is provided by alternating current of 50 periods per second, so that there are 100 flashes of illumination per second. The exposure lasts for a long enough time for the falling particles to appear each as a discontinuous line, like a string of beads, and the distance from one of these beads to the next is, of course, the distance traversed by the moving particle in 0·01 sec.

In this way it was found that the rate of fall of emery grains of an average diameter of 0·005 cm. is 6 cm. a second, and grains of this size are quite large enough to cause very bad scratches. If now we take a similar photograph in ordinary moving air of a workshop during working hours, we find that the movement of air is such as entirely to outweigh the tendency of the particles to fall. The particles move both upward and downward, according to the eddies of the air, and at vastly greater speeds than the rate of fall due to gravity. Good ventilation requires that the air in a room in which anyone is doing hand-work should be renewed at least six times an hour, and it is extremely difficult to fulfil this condition without causing currents of air sufficient to raise particles of this size against the action of gravity.

The other objection to the use of the proof plate is that it increases the time required for the piece of work to acquire a uniform temperature, and this may waste quite a lot of time. For example, in the final stages of polishing prisms, it is essential that, before testing, the temperature should be allowed to settle down. As a rough guide one may say that a 60° glass prism, 2 in. high and of 2½ in. length of face, which is being polished by hand, requires about half an hour to settle down. If the test is made sooner, the prism may be so much distorted by inequalities

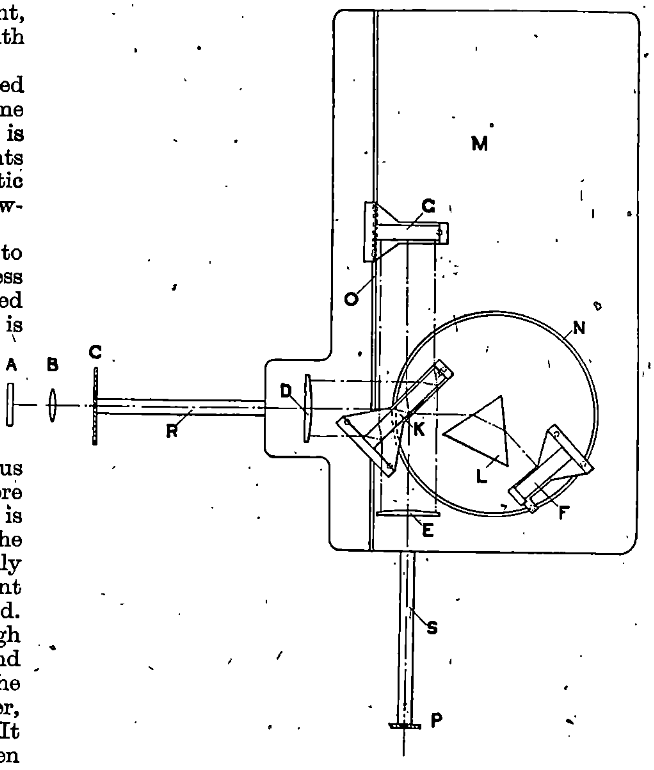

Fig. 5.

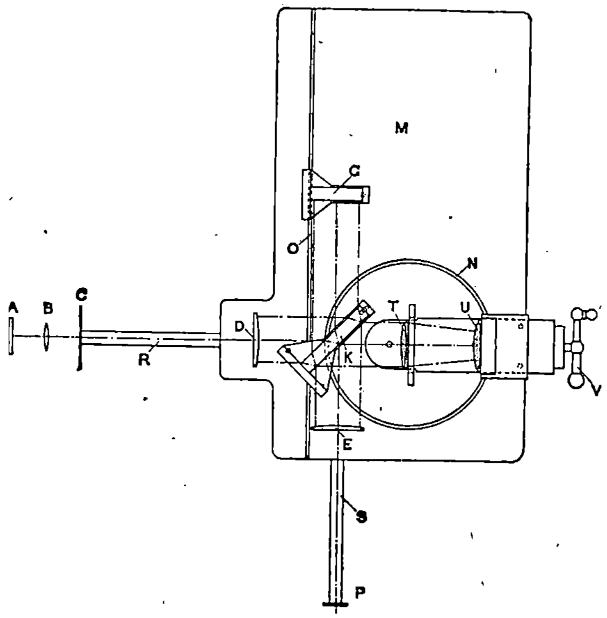

Fig. 6.

of temperature that the test is unreliable. If the test is made by a proof plate, then even if both proof plate and prism are allowed to become of the same temperature before being put together, the temperature is liable to become non-uniform owing to variation of workshop conditions. This liability is greatly reduced if the prism can be placed with all its surfaces exposed to the air, as on the interferometer.

Thus the interferometer may serve a useful purpose in replacing, on occasion, the very much simpler proof plate. This, however, is a very minor part of its use in the workshop.

All optical systems have for their purpose to receive a beam of light which originates from a point, and to alter the shape of its wave front in a predetermined way. For example : Fig. 5 shows the interferometer as arranged for testing a 60° refracting prism. Such a prism is required to receive a beam of light which has a plane wave front and to deliver it after transmission also with a plane wave front. If the wave front is distorted, whether that be due to the surfaces not being flat or the glass not being homogeneous, the appearance seen by the observer on the interferometer is an interference pattern which represents, in the form of a contour map, the aberrations of wave front produced by passage of the beam twice through the prism. We can, as it were, apply a proof plane to the wave front to ascertain how much it has been distorted by a piece of optical work.

Fig. 6 is an interferometer to which additions have been added for testing lenses. The right-hand mirror of the instrument has been removed and replaced by an optical system consisting of the lens *T* under test and the convex mirror *U*, so arranged as to send the rays back along their own path. If a plane wave falls on *T*, it should then, if the lens and mirror are perfect, emerge from *T* on its return path, still in the form of a plane wave. If it does not, we can see exactly what parts of the lens are responsible for the error and can usually, at the same time, judge quite easily from what cause the error arises.

There is a specialized form of instrument to deal with photographic lenses. Fig. 7 shows the appearances seen with a lens on the camera lens interferometer for a point off axis. The error is that characteristic of the form of aberration known as 'coma'.

The interferograms, if I may call them so, are, then, contour maps to a scale of half wave-lengths of the errors of wave surface caused by transmission through, or reflection from, the object under test.

Having observed in this way what is the error of wave front produced by an optical element, what is the optician to do about it ? That depends on practical considerations. If the piece is one of a number made together in a block, he may put it back with others for re-working. But first of all it is highly desirable that he should know whether the defect is due to the glass not being homogeneous or to the surfaces being imperfect, for if he has a number to do and the glass is heterogeneous, his production may easily be reduced to less than one half of what it is when the glass is perfect; and it may be cheaper, and indeed quicker, entirely to reject that particular batch of glass and go on to another.

For making such a decision the interferometer is invaluable. Suppose we are dealing with the production of high-quality plane parallel glass, and are having trouble of this kind, we can, with the utmost ease, determine both the variation of refractive index and the variation of thickness. We map out upon the surface of the plate, first the interference pattern obtained by the ordinary use of the interferometer, and then the pattern obtained by back reflection from the two surfaces—this can be done on one and the same instrument. Then it is a matter of quite simple arithmetic to say what are the differences of thickness and of refractive index at the points where the lines of the two patterns cross. An accuracy of 5 units in the sixth place of decimals in the refractive index, and 10^{-6} in. in the thickness, can be attained in this way.

If it is the refractive index that is at fault, and there is no other glass available, the optician may proceed to correct the optical performance by retouching. With the interferometer this is an extremely simple operation—as simple as levelling a seed bed in a garden. One rubs with a rouged pad on the high places until the interference appearances show that the work is good. The interferometer tells exactly where to rub and how much.

Now to give an illustration of other uses of the instrument.

Let us suppose that two 60° angles are to be compared, one being the standard. One prism is stood

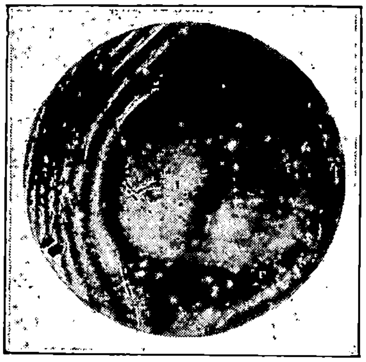

Fig. 7.

on the other, and they are placed on the instrument in place of the mirror *F* (Fig. 5) so that the interference fringes are obtained from both surfaces. The top prism is then tapped gently until the face under observation is parallel to that of the standard. Both prisms are now rotated so that their other faces are presented to the beam. Needless to say, this rotation must be very carefully done to avoid shifting the top prism relative to the bottom one. A slight rotation must now be given to the diagonal plane of the interferometer, in order to make the fringes on the standard horizontal. Then if there is any angular difference between the prisms, the fringes seen on the other prism will be tilted, the number of fringes cutting the horizontal separating line being a measure of this angular difference. If the interference bands are formed by the green light of a mercury vapour lamp, each band represents 10^{-5} in.

To test the 90° angle of a roof prism the side mirror *F* of the instrument is swung round to the right-angle position and the roof prism placed on a table of suitable height to reflect the light on to the mirror. The appearance of two horizontal bands indicates that the angle of the roof is not quite 90°. If the angle is smaller than 90°, then by pulling the telescope rod gently in a downward direction (which increases the path length of the light reflected in mirror *G*), the fringes will move inwards towards the dividing edge.

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[1] Twyman and Green, British Patent 103832/16. Twyman, British Patent 130224/18.

[2] Twyman, F., *Phil. Mag.*, 35, 49; *Trans. Opt. Soc.*, 22, 4; *Trans. Opt. Soc.*, 24, etc.

VENEREAL DISEASE

LIAISON BETWEEN SERVICE AND CIVIL AUTHORITIES

By MAJOR J. MARSHALL, R.A.M.C.

FOR the past two years, in the treatment of venereal disease, the Services in Great Britain have had the help and co-operation of certain civil clinics. Under a scheme devised by the Ministry of Health and the Service authorities, these clinics agreed to carry out surveillance and after-treatment of Service venereal disease cases on the same lines as those used in Service hospitals and clinics. Often the use of civil clinics has meant an immense saving of time and transport in districts where there is no convenient Service venereal disease centre. The purpose of this article is to show how the scheme is working in the Eastern Command and London District.

Service men who contract venereal diseases are always admitted to a Service hospital and are treated there until they are free from symptoms, non-contagious, and fit to resume full duties. After-treatment or surveillance is carried out at the clinic, civil or Service, nearest the man's station. Before a man leaves hospital, he is given verbal instructions regarding his after-care, and his medical officer receives a proforma giving the address of the chosen follow-up centre and naming the date and time for the first appointment. If the man is to attend a civil clinic his medical officer sends with him a case record card each day he attends. On this card is a pencilled scheme of treatment for the guidance of the civil specialist. It is appreciated on both sides that this is only a guide and does not apply where the civil specialist finds that other measures are necessary. A list of all clinics, civil and Service, in the area is sent to the unit medical officer when necessary. Regimental medical officers are encouraged to get in touch with the specialist at the local venereal disease centre whenever possible so that the best arrangements can be made to accommodate Service cases at the clinic.

If a Service man, without first consulting his own medical officer, visits a civil clinic and is found to be in an acute infectious condition, the specialist advises the man to report at once to the military authorities so that he may be admitted to hospital.

Civil clinics have no means of check on Service defaulters as, for reasons of security, unit locations cannot be disclosed. Most clinics, however, send lists of defaulters periodically to the Command venereologist, and the men are traced. In most cases they are found to be continuing treatment at another centre after a unit movement, but if they are true defaulters, arrangements are made for them to resume treatment.

Some civil clinics have arranged special sessions for Service cases and all have helped greatly in their efforts to deal quickly with Service men so that there shall be the least interference with duty. In certain clinics, where time, pressure of work, or other reasons have made it difficult for the civil staff to deal with Service men, the clinic has been lent to the Command venereologist for a few hours each week, and a special Service clinic has been opened.

For men leaving the Services before treatment is completed, arrangements are made for them to continue at the civil clinics nearest their homes.

Every effort is made to bring the female source of infection under treatment. When a patient knows by whom he has been infected, he is encouraged to write to the woman, telling her of the importance of seeking medical advice, and enclosing a sealed addressed letter for her to take to the specialist at the civil venereal disease clinic nearest her home. This letter informs the specialist of the nature of the suspected disease. When his patient permits, the specialist informs the sending hospital that the woman has attended and of his findings. The number of women brought under treatment by this method has more than justified the scheme.

When dealing with marital cases it is often a great help in avoiding family upsets if the same doctor can deal with both parties. This is especially the case in those instances where a man has unwittingly exposed his wife to infection during the incubation period of one of the venereal diseases, and commanding officers are co-operating by allowing a man time off to accompany his wife to the clinic on the first visit. In this connexion the London Lock Hospital has helped by lending its female clinic for a morning each week when the Command venereologist may see Service men's wives who are resident in London. The Command specialist is able to transfer to members of the honorary staff of the hospital any special cases falling outside the province of venereal disease, such as obstetric or gynæcological conditions.

In conclusion, it may safely be said of the collaboration of the civil and Service venereal disease systems that both sides have done their best to make the scheme a success, and that the results have been most encouraging. The thanks of all concerned are due to the civil venereologists, public health and hospital authorities who have assisted so greatly in this matter.

OBITUARIES

Sir Henry Miers, F.R.S.

Sir Henry Miers passed peacefully away on December 10 in his eighty-fifth year at his home in West Hampstead after a fortnight's illness. A man of unusual versatility, he gained eminence as a mineralogist and crystallographer, as a university administrator, and as a museum authority. Having had the advantage of what was commoner in his day than now, a classical education, before taking to mathematics and science, he had the gift of a fluent and lucid style of writing, as is evident in his numerous publications. Despite the partial failure of eyesight which afflicted him in his closing years and restricted his activity, he maintained up to the end his interest in all the matters that had formerly occupied his attention. When reading became difficult, he took up as a hobby the study of plants.

Henry Alexander Miers came of a family that had already shown some proclivity towards science. John Miers, F.R.S., well known as a civil engineer and in his later years as a botanist, who accompanied the great seaman, Lord Cochrane, at his invitation to South America in 1818, in order to develop the mineral resources of Chile, and in the course of his travels made an extensive collection of South American plants, now in the British Museum, was his grandfather, and Edward John Miers, who was on the staff of the Zoological Department of the British Museum from 1872 until 1885, when ill-health compelled his retirement, and was an authority on Crustacea, was his elder brother. He himself was born at Rio de Janeiro on May 25, 1885, his father, Francis Charles Miers, being at that time in business there as a civil engineer.

Miers was educated at Eton College, where he was a King's Scholar, from 1872 until 1877, and at Trinity College, Oxford, where he held a classical scholarship, from 1877 until 1881. He transferred his studies to mathematics, however, and graduated with second-class honours in mathematical moderations in 1879 and finals in 1881. In 1900 he proceeded to the newly instituted degree of D.Sc.

On going down from Oxford, Miers joined the staff of the Mineral Department of the British Museum on the inducement of Mr. (afterwards Sir Lazarus) Fletcher, who was keeper, in 1882, very soon after the removal of the collection from Bloomsbury to the new building at South Kensington. He assisted in the arrangement of the specimens in the Mineral Gallery and in the preparation of the crystallographic catalogue which had been projected. As the result of his studies he published numerous articles and memoirs on the morphology of various minerals. With his museum duties he combined the post of instructor in crystallography at the Central College, South Kensington, from 1886 until 1895. He was editor of the *Mineralogical Magazine* from 1891 until 1900.

In 1895, when N. Story-Maskelyne retired from the chair of mineralogy at Oxford and the opportunity was taken to revise the post, Miers was appointed to fill the vacancy and became the first Waynflete professor, the post having been combined with a fellowship at Magdalen College. Hitherto only courses of lectures had been given, so that Miers had as his first task to effect teaching arrangements and organize laboratory work as well as improve the mineral exhibition in the University Museum. Among his earliest pupils was H. L. Bowman, who became so fascinated with the subject that he remained to assist him, and eventually succeeded him in the chair. Miers took up a task which he had in his mind for some time, namely, the preparation of a comprehensive treatise on mineralogy; it was published in 1902 ("Mineralogy: An Introduction to the Scientific Study of Minerals", Macmillan). The second edition, which appeared in 1929, was undertaken by Bowman. During this period Miers carried on the research, upon which he had been privately engaged in London, on the conditions which determined the kind of crystals formed in a saturated solution, and cleared up many obscure points.

While at Oxford, Miers soon acquired a reputation for administrative ability, and consequently, when in 1908 a successor to Sir Arthur Rücker was sought in the difficult and onerous office of Principal of the University of London, he was chosen. Although no great changes occurred during his period of office, it was in the following year that a Royal Commission was appointed under Lord Haldane's chairmanship to investigate the whole question of university education in London. It reported in 1913, but owing to the outbreak of war in the following year, nothing was then done to carry out any of the recommendations in the report. Soon after, in 1915, Miers was translated to Manchester as vice-chancellor of the University, and such success did he achieve in this office that he was pressed to remain after reaching the normal age for retirement, and did not vacate the post until 1926. It was a great pleasure to him to return to teaching by acting as professor of crystallography.

When he had finished at Manchester, Miers returned to London to live, and settled down at West Hampstead for the rest of his life. He was by no means idle: he was promptly elected a trustee of the British Museum, thereby creating a precedent, for never before had a former member of the staff become a trustee, and was also appointed a member of the Royal Commission on National Museums and Galleries, which issued its interim report in 1928 and its final report in two parts in 1929 and 1930, and in 1931 of the newly created Standing Commission on Museums and Galleries. Simultaneously, he was invited by the Carnegie United Kingdom Trust to report on the museums, other than national, in the British Isles, and with the help of S. F. Markham did so in 1928. Almost immediately afterwards, the Carnegie Corporation of New York asked him to make a similar survey of the museums in British territory overseas. With the aid of S. F. Markham, C. Squire, and D. W. Herdman he reported on the museums in Canada and British Africa in 1932; he himself visited both countries. It was an obvious consequence of this work that in 1928 he was elected president of the Museums Association, and once again he proved so successful that he was prevailed upon to continue in office for an unprecedented length of time, and did not vacate it until 1933.

During 1904–9 Miers was president of the Mineralogical Society, and during 1932–37 of the Gemmological Association. In 1941, owing to his defective sight, he was compelled to resign from the trusteeship of the British Museum and membership of the Standing Commission on Museums and Galleries. He was knighted in 1912, elected a fellow of the Royal Society in 1896, and awarded the Wollaston Medal by the Geological Society of London in 1934. Numerous other distinctions, including honorary degrees, were conferred upon him.

G. F. Herbert Smith.

Dr. E. J. Allen, C.B.E., F.R.S.

THE Rev. Richard Allen of Lancashire, and his wife Emma Johnson, of Bideford in Devon, had good reason to be proud of their family of eight, which consisted of five sons and three daughters, four of whom survive. The sons were the late Dr. H. N. Allen, professor of electrical engineering and afterwards principal of the College of Science at Poona; the late Mr. C. B. Allen, assistant general manager of the Midland Bank; the late Dr. E. J. Allen, F.R.S., until 1936 director of the Marine Biological Laboratory at Plymouth; Mr. E. L. Allen, of the School of Art, Redditch; and Dr. H. S. Allen, F.R.S., professor of natural philosophy at St. Andrews.

Edgar Johnson Allen, the second son, was born at Preston in 1866, educated at Kingswood School, Bath, and at the Yorkshire College, Leeds. He graduated as an external student of the University of London with honours in chemistry in the Intermediate B.Sc. (1884) and physics in the Final B.Sc. examination (1885). For financial reasons some years were spent in teaching posts, including the headmastership of a school in the West Indies. After his return to Europe, he was engaged in post-graduate study in zoology in the University of Berlin and also at University College, London. In 1900 he graduated as D.Sc. in the University of London and won the Sherbrooke Scholarship. He had already received a research grant from the Royal Society (1893) which enabled him to work at Plymouth.

In 1895 he became director of the Marine Biological Association's Plymouth Laboratory and secretary to the Council, posts which he held for forty-two years, until his retirement in 1936. Under his guidance the Laboratory prospered and became a centre of marine research. It became a centre of physiological research also, for Allen realized the importance of marine animals and plants as subjects for the study of general problems of biology and medicine. Accordingly, it came about that the last scientific paper read by one of his old staff on his way to take up duty as a naval officer was before the Royal Society of Medicine upon the semi-circular canals of the ear, studied through the response of single nerve fibres.

During the earlier years much of the research and the observational work at sea were carried out by Allen himself. But as years went on his duties as director became more arduous and his time was occupied with routine, with advising younger men and attending to the wants of the numerous research workers who came to the Laboratory from distant lands. The impact of the visitors upon the regular staff was, in his view, specially good for the latter, and tended to prevent the departmental miasma of an official laboratory from enveloping them. It was, therefore, a pleasure to him when his attention was directed to Sir Lawrence Bragg's presidential address to the Institute of Physics last July and it was suggested that his moulding of a research institution was upon the lines considered by Bragg to be most desirable.

But though his unremitting and unselfish care for his laboratory left him little time, Allen contrived also to be a good Plymothian and served upon a number of committees. He gave much thought also to the Tees and Mersey Survey Committees of the Department of Scientific and Industrial Research and to the work of the Water Pollution Research Board.

Allen's work brought him general recognition in the learned world. In 1914 he was elected a fellow of the Royal Society. In 1922, at Hull, he was president of the Zoological Section of the British Association. In 1923 the Hansen Memorial Medal and Prize came to him from Denmark. In 1926 he received the Gold Medal of the Linnean Society, followed by the Darwin Medal of the Royal Society in 1936 and the Agassiz Medal for Oceanography of the National Academy of Sciences, Washington. In the previous year he had been made C.B.E. He was also a foreign member of the Royal Academy, Denmark, and an hon. LL.D. of the University of Edinburgh.

Of Allen's forty-three published papers and addresses, twenty-five appeared in the *Journal of the Marine Biological Association*, which he edited for so long. Some of his best early work on the nervous system of the Crustacea appeared in the *Quarterly Journal of Microscopical Science*, and other work on crustacean embryology and histology appeared in the *Proceedings of the Royal Society*; while his work on regeneration and reproduction of the Syllid Procerastea was published in the *Philosophical Transactions*. His work on the culture of planktonic diatoms opened up a trail which has since been actively followed. Of his papers two, on estuarine fauna, were with R. A. Todd. The first diatom paper was with the late E. W. Nelson and in two, dealing with the genetics of Gammarus, he collaborated with Mrs. E. W. Sexton.

E. J. Allen's end came peacefully on December 7 after one day of indisposition, while still full of interests and enjoying a retirement with leisure he had previously lacked. W. R. G. ATKINS.

Lieut. W. Neil Paton, D.S.C., R.N.V.R.

AFTER many valiant aerial combats, which won him the Distinguished Service Cross and a mention in dispatches, William Neil Paton was reported missing off Malta in June last and has now been officially presumed killed. Marine biology has lost a recruit of great promise. Born in September 1914, the second son of Dr. and Mrs. J. Hunter P. Paton of St. Andrews, he was educated at Oundle and Magdalen College, Oxford. After graduating in 1937 he joined the Oxford University Expedition to Grand Cayman and returned in the following summer with a rich zoological collection. He then joined me in experimental work on the vertical migration of the marine plankton being carried out at the Millport Marine Station and was later appointed to the research staff of the Station.

Soon after the outbreak of war, Paton volunteered for service with the R.N.V.R., and received his commission in the spring of 1940. Later he transferred to the Fleet Air Arm and was stationed at Malta. The Admiralty reported the award of the D.S.C. in the following terms: "for outstanding courage and determination in the face of the enemy. This officer carried out sixteen air operations from Malta in all of which he made contact with the enemy and in seven of which enemy shipping was destroyed or damaged. On eight of the operations he was leading the force and was largely responsible for its success". He was mentioned in dispatches for his last action: "the enemy ships, escorted by a strong force of shore-based fighters, were attacking an allied convoy bound for Malta when our aircraft engaged them and pressed home a determined attack in the face of bitter resistance".

Paton threw himself into his scientific work with the same determination; he was a splendid experimenter, never discouraged by failure, always seeking a way to get over difficulties. I am at present preparing his work for publication. He was a man of wide interests and a very human personality, endearing himself to all he came in contact with. To end this brief note I cannot do better than quote a letter from his Oxford tutor: "it is a literal statement of fact to say that life is poorer because one has not sometimes the thought that Neil Paton may be coming around".

Our sincerest sympathy goes to his parents who lost their other son, also in the Fleet Air Arm, in the same way: missing, then presumed killed.

A. C. HARDY.

WE regret to announce the following deaths:

Prof. Rudolf Abel, formerly professor of hygiene in the University of Jena, the eminent German bacteriologist, aged seventy-four.

Prof. F. D. Adams, F.R.S., emeritus Logan professor of geology, dean of the Faculty of Science and vice-principal, McGill University, on December 27, aged eighty-three.

Prof. Franz Boas, emeritus professor of anthropology in Columbia University, on December 21, aged eighty-four.

Dr. Mabel C. Buer, lecturer in economics in the University of Reading, on December 9, aged fifty-one.

Sir Bryce Chudleigh Burt, C.I.E., M.B.E., director of animal feeding stuffs, Ministry of Food, secretary of the Indian Central Cotton Committee during 1921–28, agricultural expert to the Imperial Council of Agricultural Research during 1929–35, on January 2, aged sixty-one.

Prof. W. Caldwell, emeritus professor of philosophy in McGill University, aged seventy-nine.

Prof. F. M. Cornford, F.B.A., emeritus professor of ancient philosophy in the University of Cambridge, on January 3, aged sixty-eight.

Mr. F. W. Harbord, C.B.E., the well-known metallurgist, on December 27, aged eighty-two.

NEWS and VIEWS

New Year Honours List

THE following names of scientific men and others associated with scientific work appear in the New Year honours list:

Baron: Sir Charles Wilson, president of the Royal College of Physicians.

Baronet: Mr. W. M. Goodenough, chairman of the Nuffield Trust for the University Medical School, Oxford.

G.B.E.: Sir Henry Dale, lately director of the National Institute for Medical Research, president of the Royal Society.

K.C.B.: Sir Wilson Jameson, chief medical officer, Ministry of Health and Board of Education.

Knights: Prof. J. H. Clapham, president of the British Academy; Prof. F. Clarke, professor of education, University of London; Prof. A. C. G. Egerton, professor of chemical technology, Imperial College of Science and Technology, and joint secretary of the Royal Society; Jhanendra Chandra Ghosh, director of the Indian Institute of Science, Bangalore; Mr. S. H. Howard, inspector-general of forests and president of the Forest Research Institute, Dehra Dun; Pestonji Rustom Masani, lately vice-chancellor of the University of Bombay; Mr. W. A. Stanier, chief mechanical engineer L.M.S. Railway and scientific adviser to the Minister of Production; Brig. E. O. Wheeler, surveyor-general of India; Mr. J. Wright, chief engineer, Central Electricity Board.

C.M.G.: Mr. D. Yates, a leading metallurgist of South Australia.

C.I.E.: Bhagavathulu Viswanath, officiating director, Imperial Agricultural Research Institute, New Delhi; Mr. R. A. MacGregor, chief metallurgist, Department of Supply, Calcutta.

C.B.E.: Dr. W. R. Aykroyd, director of nutritional research, Coonoor; Mr. E. Barnard, director of food investigation, Department of Scientific and Industrial Research; Mr. R. Gushue, chairman of the Fisheries Board, Newfoundland; Mr. E. H. E. Havelock, administrative secretary of the Agricultural Research Council and secretary of the Development Commission.

Prof. G. A. R. Kon

PROF. G. A. R. KON, whose appointment to the chair of chemistry at the Chester Beatty Research Institute, Royal Cancer Hospital (Free), was recently announced, is a graduate of the University of Cambridge; but his career as a chemist has until now been connected with the Imperial College of Science and Technology. Beginning research there in 1914, he was one of the band of workers associated with the late Sir Jocelyn Thorpe in the founding of his school of organic chemistry. Prof. Kon's early work dealt with ring formation and the like, and in the course of it he came across certain ketones exhibiting unusual properties. After the presentation of his D.Sc. thesis in 1922 he followed up these early observations, embarking on a long series of investigations dealing with three-carbon tautomerism, a phenomenon which had not, until then, received systematic attention. One outcome of this work, to which Prof. R. P. Linstead also made substantial contributions, was the elucidation of the chemistry of the glutaconic acids. The contradictory nature of these compounds, which had previously been the subject of controversy between Thorpe's school and that of Feist in Germany, was shown to be due to the simultaneous existence of three-carbon tautomerism and stereoisomerism.

In 1932 Prof. Kon wrote the section on homocyclic compounds in the "Annual Reports on the Progress of Chemistry", and this date marks a complete change in the direction of his work. Having been hitherto concerned solely with aliphatic compounds, he directed his attention to problems connected with the sterols and related substances. He synthesized "Diels's hydrocarbon", $C_{18}H_{16}$, which forms the basis of the sterol skeleton, and helped to evolve the formula of the cardiac aglucones on the basis of the degradative work of Jacobs on strophanthidin. He then turned his attention to the triterpenes. Aided by a number of capable pupils, he largely elucidated the constitution of bassic and quillaic acids. The latter result, in turn, necessitated the revision of the structure of related compounds belonging to the β-amyrin group, for which a new formulation was proposed. A feature of this work, made possible by collaboration with P. Bilham, was the use of the surface film method for ascertaining the position of the functional groups in these large molecules.

William Hedley : Locomotive Pioneer

ON January 9, 1843, William Hedley, one of the pioneers of the locomotive and iron railway, died at Burnhopeside Hall, near Lanchester, Co. Durham, and was afterwards buried at his birthplace, Newburn on the Tyne. He was then sixty-three years of age, having been born on July 13, 1779. He seems to have had a good education and in his 'twenties became a viewer at the colliery in the village of Wylam, eight miles west of Newcastle-upon-Tyne, where George Stephenson was born in 1781. The colliery was the property of Christopher Blackett, a man with progressive ideas, who in 1804–5 had had a locomotive built at Gateshead to Trevithick's plans. This engine, it appears, was never put into service. In 1811, with Blackett's approval, Hedley made both model and full-size experiments to show that a locomotive with smooth wheels could operate successfully on smooth rails. These experiments led to the construction of some of the earliest locomotives, which were used for the transport of coal from Wylam Colliery to the staithes at Lemington, five miles lower down the river. One of these engines, supposed to have been built in 1813, is the historic *Puffing Billy*, now in the Science Museum, South Kensington. Hedley was as much concerned with the winning of coal as its transport, and during the last twenty years of his life worked or owned various mines in Durham and Northumberland. His own share in the development of the locomotive was clearly stated by him in a letter of December 10, 1836, to Dr. Lardner, who in a lecture at the Literary and Philosophical Society, Newcastle, had spoken of George Stephenson as the "Father of the Locomotive".

Chemical Industry in Europe

IN a recent issue of the *Chemiker Zeitung* an attempt is made to show that chemical industry in Europe is gradually increasing its productive capacity; to such an extent indeed that, after the War, Europe will be entirely independent of Anglo-Saxon domination. Presumably under the beneficent leadership of Germany, together with the organizing and technical skill that this is supposed to include, Europe would no longer need foodstuffs and raw materials from the British Empire: these would be replaced by synthetics, and the reign of *Ersatz* would be almost universal. A survey is made of the chemical industries of the chief European countries, from which Germany, and, of course, the U.S.S.R., are excluded, as also is Turkey. Many of the data, however, are pre-war, or hopeful forecasts of the future. This is more particularly the case with Italy, where some index figures are quoted for the period 1935–39 to show the rapid rise in her chemical output. In France also, practically all that could be said is that a large company has been formed for the production of synthetic fuel from lignite. It is said to be financed by the Banque de Paris, doubtless backed by German financiers or industrialists; but it will be three years before the requisite plant, using the Fischer-Tropsch process, can be installed.

If the intention was to show that European chemical industry, apart from spasmodic attempts to increase output of war munitions, is laying firm foundations for post-war expansion or even taking any appreciable steps in that direction, then the record, on the German writer's own showing, indicates complete failure. As a piece of propaganda it could scarcely deceive even the Germans themselves. Much more space, indeed, is devoted to countries not yet overrun by the Nazis, such as Spain and Sweden, and it is clearly and indubitably shown that only in those countries has any real progress been made in the chemical and allied industries. This is confirmed by non-German and more reliable sources. As a matter of fact, in the German record, many important items are omitted, as if the writer had suddenly realized that he had already said too much and exhibited too painfully the great contrast between German-occupied and unoccupied Europe. Spain's progress in the matter of nitrogenous and other fertilizers is described at some length, and reference made to new factories for the manufacture of tanning materials, sulphur and copper from pyrites, leather, textiles and artificial fibres. Many of Sweden's recent developments in chemical industry are also noted. Compared with these, the few details given about the occupied countries are insignificant trifles, and relate mainly to more or less temporary expedients to replace with indigenous products those which can no longer be obtained from Germany.

The U.S.S.R. in War-time

THE broadsheet "Soviet Planning in War-Time" issued by P E P (Political and Economic Planning) gives a useful objective account of the ways in which the Russian economy has advanced from one mobilized for war in 1941 to a battle economy, and of the general background of this economy. The machinery of Soviet planning functions through three main stages: first, a comprehensive survey of existing resources; secondly, the formulation of a plan, which is simply the laying down of a series of output programmes which must be carefully dovetailed into each other so that they are consistent; and, thirdly, a mechanism for checking their progress and for providing the elasticity necessary for periodic adjustments. This machinery was evolved over a considerable period of time, and the broadsheet gives a brief account of the purposes and achievements of the three Five-Year Plans. It was only during the Second Five-Year Plan that the consumption of foodstuffs and living standards generally rose to any appreciable extent, but an important aspect of that period was the development, partly for strategic reasons, of industrial and raw material resources east of the Urals. Both the First and the Second Five-Year Plans between them largely achieved their objectives of the creation of modern large-scale industry and a mechanized agriculture as the basis for raising living standards to a higher level and for national self-sufficiency in war-time.

The Third Five-Year Plan provided for further increases in the output of industry and agriculture, but its most striking feature was the huge increase in the resources devoted to defence. Moreover, the whole organization of Russian economic life, with its machinery for central planning and its high degree of military preparedness, makes for a greater degree of continuity between peace and war economies than in any other country except Germany. Owing to the absence of excess capacity, the war sector from the outset had to be expanded at the expense of the peace sector of the economy. The producers' goods industries were, so far as possible, adapted to war production and the output of these industries was reduced. Agriculture was seriously affected by labour shortage due to mobilization, which was only in part made up by urban workers and spare-time labour. Excess purchasing power seems to have been skimmed chiefly by increased subscription to State loans. To offset the heavy losses in production resulting from Nazi occupation of European Russia, great efforts, apart from the evacuation of industrial plant and rolling stock, have been made to increase the absolute absorptive capacity of the Ural and Asiatic regions. New sources of raw materials are being exploited, new power stations established, new coal pits sunk and new oil wells drilled. New plantations of rubber-bearing plants, of sugar beet, etc., have been developed, and new substitutes and methods are being employed for the manufacture of sugar and soap. In all this, scientific workers have played a great part, as well as in the simplification and rationalization of many technical processes.

The Solway Tides

A great tidal wave occurred on the Solway estuary on the night of December 9–10, when 3,000 acres between the Rivers Sark and Esk were under water and Sark Toll Bar marriage house was isolated, while 7-ft. fences on Sark Foot farms were submerged. The tide was 25 ft. and was made abnormal and destructive by the wind that came in the wake of a great tidal wave. On the Scottish side the floods reached the highest recorded level since 1900, cattle and sheep were drowned, farmhouses isolated. A 9-ft. embankment was broken in two places along the River Annan and houses were flooded in the Scottish town of Annan. It might have proved more costly but for the fact that because of the mild weather few farmers had brought their sheep down from the mountains to the estuary marshes. The Solway Firth has a history of great tides serious to local farming. Some years ago a tide with less water than that of December 9 killed nearly 1,000 sheep, owing to all the winter flocks being on the marshes. In 1942 the Solway had its usual two high tides of the year, in August and November, and the December one was unexpected.

English Lakeland Fauna

There has been a considerable extension of our knowledge of the fauna of the English Lakeland by the activities of the Carlisle Natural History Society. A list of 292 species and sub-species has been drawn up in a manuscript book on "The Birds of Lakeland" to be published after the War, a considerable number of nesting species being added to the Rev. MacPherson's old "Fauna of Lakeland". At a recent meeting of the Society in Carlisle Museum, F. H. Day recorded six new species of Coleoptera added to the Cumberland list in 1942, bringing the total list to 1,849. The new additions are *Triplax aenea*, Schall.; *Gabrius velox*, Shp.; *Aphodius constans*, Duft.; *Liodes glabra*, King.; *Hylastes opacus*, Er.; and *Scolytes intricatus*, Ratz., from an oak log. It was also reported that in 1942 there had been an increase in the range of wall brown and peacock butterflies, also the cinnabar moth in coastal regions, while the rare greasy fritillary butterfly still maintained certain local haunts. A cream-coloured curlew nested at Hosketh Hill and the quail in a clover field at Durdar. The blackcock is still numerous in many haunts. There is a regular pied wagtail roost on the glass roof of Carlisle railway station and another roost in willows by the Caldew. The willow-tit has been recorded in a number of Lakeland localities and a grey shrike was reported from near Brampton at the end of November. Whooper swans remained on a local water until the second week of May.

Earthquakes Registered in Spain

During September 1942, thirteen strong earthquakes were registered by the seismographs at the observatory at Toledo. On September 1 there were three shocks, the first beginning with *iPz* at 9h. 47m. 34s. U.T., attaining an amplitude of 13 μ on the N.S. component at 9h. 52m. 01s. U.T. and finishing at 10h. 50m. U.T. The shock apparently came from an epicentre distant 2,980 km., the focus being some 250 km. deep. The other two shocks were much smaller. The earthquake on September 6, which registered at 16h. 06m. 34s. U.T., came from an epicentral distance of 9,470 km. and that on September 9, which registered at 1h. 37m. 59s. U.T., from an epicentral distance of 9,245 km. On September 24 an earthquake which began registering at 3h. 56m. 34s. U.T. attained an amplitude of 11 μ at Toledo at 4h. 42m. 46s. U.T. and finished recording at 5h. 10m. 00s. U.T. It came from an epicentre distant probably 11,710 km. The last earthquake registered in the month was on September 26 at 4h. 12m. 09s. U.T., probably from an epicentral distance of 8,465 km., and finished recording at 4h. 50m. U.T. The readings during the month were to a small extent confused by microseisms, and all readings are tentative.

Comet Whipple

Dr. W. H. Steavenson observed this comet on December 19, 22 and 29. On the last occasion he described it as large, at least 10′ in diameter, with a well-marked nucleus and a tail about 20′ long. Its magnitude was about 6 on December 29. As Dr. Steavenson is at present absent from his observatory, he was able to give only approximate positions of the comet by using a 3-in. refractor on an altazimuth mounting and estimating the positions from stars in the field. From his data Dr. M. Davidson has computed the following orbit and ephemeris, but they are only approximate owing to the nature of the observations. Those who observe the comet in the early part of the month, for which the ephemeris will probably suffice, should make the necessary corrections for later observations. The comet is approaching the earth and will be about 30 million miles away on January 28. It will almost certainly become a conspicuous naked-eye object during the month.

Orbit

T 1943 Feb. 21·20 U.T.

$$\left.\begin{array}{ll}\omega & 57{\cdot}3^\circ \\ \Omega & 100{\cdot}2 \\ i & 20{\cdot}4\end{array}\right\} 1943{\cdot}0$$

q 1·182

Ephemeris

	R.A.				
Date 1943	h.	m.	Dec.	ρ	r
Jan. 8	9	06·0	+33·3	0·418	1·369
12	9	23·7	37·0	·388	·340
16	9	43·2	41·0	·368	·312
20	10	08·0	45·5	·352	·286
24	10	35·9	49·6	·340	·264
28	11	02·6	53·3	·334	·242

LETTERS TO THE EDITORS

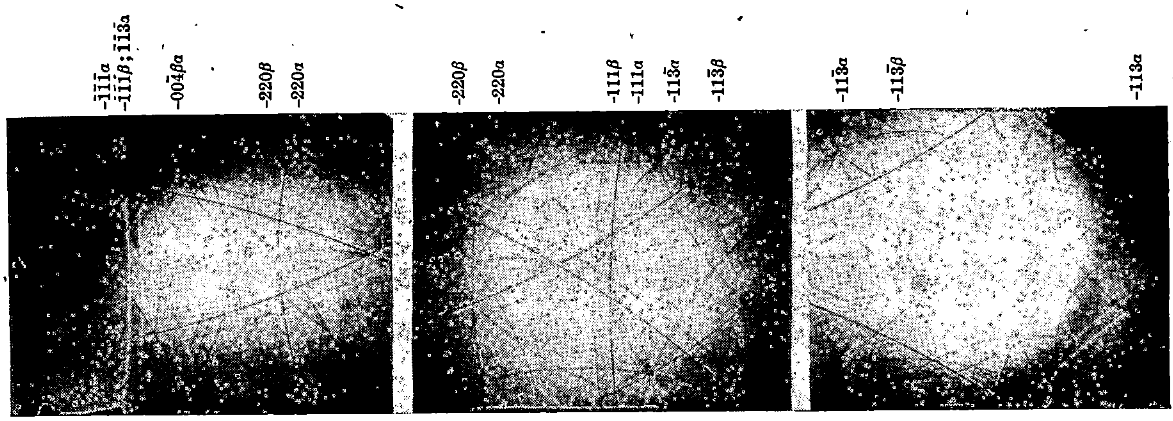
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Crystal Photography with Divergent X-Rays

KOSSEL[1] has shown that when a single crystal is used as anticathode in an X-ray tube, the divergent characteristic X-rays generated in the crystal are diffracted, according to the Bragg relation, from the various planes in the crystal itself, and a photographic film placed in the neighbourhood of the crystal will show a pattern of black and white lines (conics if the film is plane) on a more or less uniform background. These are somewhat similar to the more familiar Kikuchi lines[2] obtained by electron diffraction methods, but they are much fewer in number and are better resolved. However, Kossel lines can only be recorded when the crystals used contain elements of fairly high atomic number. Fujiwara and Onoyama[3] have obtained similar black and white lines *within the central shadow* by using a convergent primary X-ray beam; and Linnik[4] predicted in 1929 that they would also be obtained by the use of a beam diverging from a pin-hole, but suggested that the inevitable background would spoil the pattern.

This is not necessarily the case. Using a very low input tube designed by Dr. A. Müller, which gives a beam of copper X-radiation divergent externally through an angle of nearly 180°, I have obtained patterns, as shown in the accompanying reproduction, with an exposure of 30 sec. or less, the crystal being a 1·5 mm. thick plate of diamond the octahedral face of which was in direct contact with the point source on the anticathode, the photographic film some 10 cm. away. In general, such patterns can be obtained with copper radiation from any organic crystal or crystal containing atoms of low atomic weight. The lines of the pattern are mostly *deficiency* lines (black in the reproduction but white on the original film) marking those places where the primary intensity has been *reduced* by reflexion, and these cannot show up strongly unless the crystal is thick enough for considerable reflexion to have taken place during transmission. On the other hand, the crystal must not, of course, be so thick as to absorb all the copper radiation. The *reflexion* lines from a thick crystal are weak because so much multiple reflexion takes place within the crystal, and they are in any event few because most reflected rays are directed away from the film, as a simple sketch shows. A thin crystal gives weak deficiency, but stronger reflexion lines. The separation s of the deficiency and reflexion lines, measured in the plane of any incident and reflected ray, is given by $s = \frac{\sin 2\theta}{\sin(\phi+\theta)} \cdot r$, where θ is the Bragg angle, ϕ the inclination of the reflecting plane to the plane of the film, and r the distance from the point source of X-rays to the point of reflexion; s is independent of the film distance. Application of this formula shows that it is the outer layer of the crystal (farthest from the source, but nearest to the film) which is responsible for the reflexion lines found on the film.

Although most reflexion lines are not recorded on the film, deficiency lines corresponding to values of θ very near 90° may often occur in a forward direction. This enables very accurate estimates of lattice distances to be made. Moreover, one or two half-minute photographs of a suitably shaped crystal can, in theory at least, supply all the information required to ascertain the unit cell and space-group, since measurements of the co-ordinates of four points on any one deficiency curve will give D, the film-source distance, θ the Bragg angle, and λ, μ, ν (two independent) the direction cosines relative to any arbitrary axes in the crystal, of the reflecting plane. It is not necessary, although it is convenient, for the crystal to have any external faces or to be placed with its crystallographic axes in any particular positions. On account of the short exposures required, this method (which is very simple in practice) might prove to be a useful way of examining non-permanent crystals.



FILM INCLINED TO OCTAHEDRAL PLANE
Circular line, $22\bar{4}\beta$

FILM PARALLEL TO OCTAHEDRAL PLANE
Circular line to left, $22\bar{4}\beta$; circular line at top, $\bar{1}3\bar{1}\alpha\beta$: circular line at right, $33\bar{1}\alpha\beta$

FILM INCLINED TO OCTAHEDRAL PLANE
Circular line to left, $33\bar{1}\alpha\beta$; circular line to right, $331\alpha\beta$

Light-dark lines from diamond, using copper K divergent radiation.

Royal Institution,
London, W.1. Dec. 9.

K. LONSDALE.

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[1] Kossel, *Gött. Nachr. Math. Naturw. Kl.*, 1, 229 (1935); *Ann. Phys.*, 25, 512; 26, 533 (1936); *Ergeb. exakt. Naturw.*, 16, 295 (1937); Borrmann, *Ann. Phys.*, 27, 669; Voges, *ibid.*, 694 (1936); Cauchois and Hulubei, *Comptes rend.*, 206, 181 (1938); etc.

[2] Kikuchi, *Proc. Imp. Acad. Tokyo*, 4, 354 (1928); *Jap. J. Phys.*, 5, 83 (1928); Thomson and Cochrane, "Theory and Practice of Electron Diffraction" (Macmillan, London, 1939), 111 et seq.

[3] Fujiwara and Onoyama, *H ros ma J. Sci.*, 9, 115 (1939); Onoyama, *ibid.*, 125; Fujiwara, *ibid.*, 233.

[4] Linnik, NATURE, 124, 946 (1929).

Refractive Index of Coals

The polarization of the light reflected from coal surfaces has been examined by use of the same apparatus which served for an examination of the intensity of the light reflected at different angles of incidence[1]. As the photocell used had a response spreading from 4500 A. to 10000 A. with a maximum at 7500 A., a water cell was used to absorb the unwanted infra-red radiation. A No. 70 Wratten Monochromat filter was placed in front of the source, and an analysing Nicol prism before the photocell unit.

The reflected intensities of the two components, plane polarized parallel to and perpendicular to the plane of incidence, resolved by the Nicol prism, were measured for various angles of incidence. With increasing angle of incidence, the intensity of the perpendicular component increased whereas the intensity of the parallel component passed through a minimum and then increased. A clearly defined minimum was obtained when the photocell amplification was increased. With visual examination most specimens gave complete extinction at the Brewster angle, but zero readings were never obtained with the more sensitive photo-electric photometer. The angle at minimum intensity was used to calculate the refractive index of the specimen.

No.	Description of sample	Refractive Index		'Fixed carbon' (dry-ash free) %	Properties of samples	
		Parallel to bedding plane	Perpendicular to bedding plane			
25	Lignite—Xylite ex Prof. Bacon	1·54	—	—	Light brown, woody	
31	Lignite—Bohemia	1·64	—	—	Black, banded	
13	Cannel—Derby	—	1·57	—	Dull, no macro-structure	
8	Durain—Warwick	1·80	1·80	67·8	Dull, visible plant debris	
9	Durain—Northumberland	—	1·80	—	" " " "	
21	Vitrain—Leicester	1·67	1·67	61·3	Free burning and coking coals	↑
7	Vitrain—Warwick	1·70	1·70	63·1		Isotropic
17	Vitrain—Lancs	1·77	1·77	63·8		Dielectrics
23	Vitrain—Kent	1·84	1·84	80·8	Coking coals	
22	Vitrain—South Wales	1·81	1·87	74·5		↓ ↑
19	Vitrain—South Wales	1·89	1·90	88·8	Steam coals	
20	Vitrain—South Wales	1·86	1·91	86·2		Anisotropic
5	Vitrain—South Wales	1·80	1·90	95·6	Anthracites	Dielectrics
16	Vitrain—County Kilkenny	1·77	1·91	97·1		↓

Filter No. 70 (λ = 7000 A.) used throughout.

As this method is less sensitive than those available for transparent substances, special care had to be taken to estimate the position of the minimum. For each determination the galvanometer deflexions were recorded over a region of about 4° each side of the minimum, which was then determined graphically. A typical result is shown in Fig. 1. The lower curve is for a natural cleavage surface, and the upper for the same surface after polishing. This was done with fine emery papers of decreasing coarseness, rotating the specimen through 90° with each change of paper, followed by polishing on 'Selvyt' cloth with moist Goddard's Plate Powder. Although the intensity of reflected light is increased by polishing, the position of the minimum is unaltered. The results were not affected by rotation of the surface in its own plane.

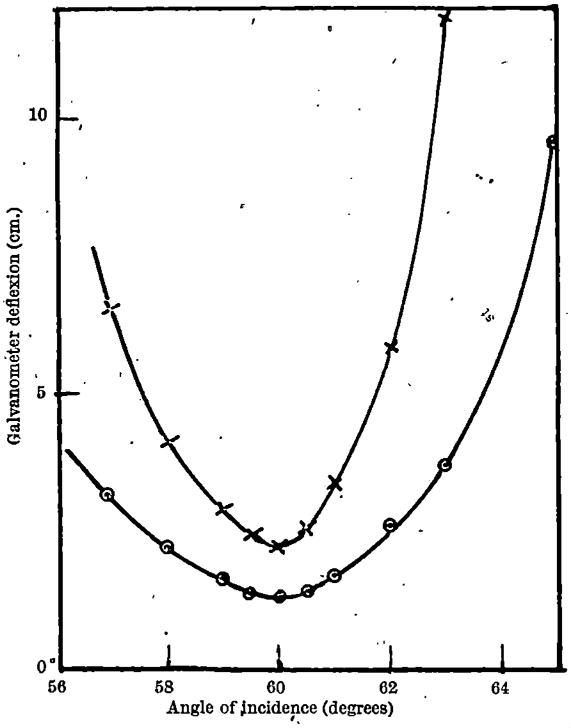

Fig. 1. Effect of polishing a coal surface. $\varphi = 60°$; tan $\varphi = \mu = 1{\cdot}73$. Crosses, polished surface; circles, natural cleavage surface.

A representative selection of results is shown in the accompanying table giving the refractive indexes, in directions parallel to and perpendicular to the bedding plane of the coals, for $\lambda = 7000$ A.

From a large range of results shown in Fig. 2 it would appear that: (i) perpendicular to the bedding plane the refractive index increases with 'rank' or geological age, as shown by the percentage 'fixed carbon' (proximate analysis), to a constant maximum of about 1·9 for anthracitic coals; (ii) parallel to the bedding plane the refractive index first increases

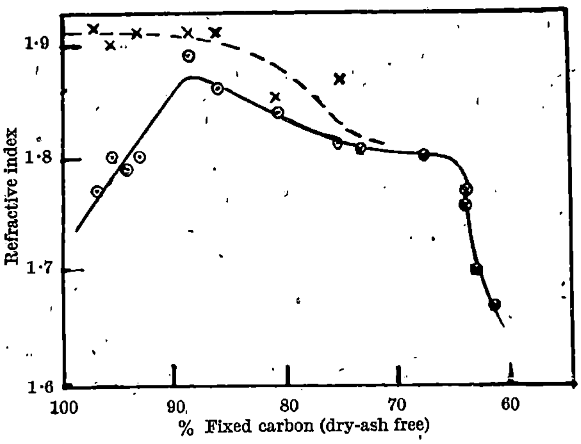

FIG. 2. REFRACTIVE INDEX IN DIRECTION PARALLEL (CIRCLES) AND PERPENDICULAR (CROSSES) TO BEDDING PLANE RESPECTIVELY.

with 'rank' and then decreases for anthracitic coals; (iii) the development of optical anisotropy coincides with the disappearance of coking properties.

For comparison, results for American coals are 1·76–1·87 for bituminous and semi-bituminous coals[2] and between 1·63 for a lignite and 1·80 for a bituminous vitrain[3]. Thanks are due to Dr. D. H. Bangham and Dr. C. A. Seyler for the loan of specimens.

C. G. CANNON.
W. H. GEORGE.

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Dec. 17.

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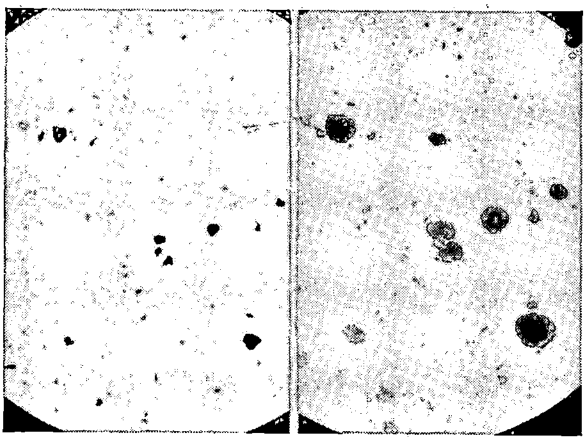
[1] Cannon and George, NATURE, 150, 690 (1942).
[2] Fisher, *Amer. Min.*, 19, 133 (1934).
[3] McCabe, *Fuel*, 16, 309 (1937).

Microscope Observations of the Crushing of Coal

So far as I am aware, the peculiar effect described below of a disruptive pressure on small particles of coal has not hitherto been observed. The observations were made in the course of an examination of very fine coal dust from a ball mill which is claimed to grind coal to micron size.



Left hand: ground coal, Swallow Wood seam, dry mounted. Right hand: the same field after crushing the coal. The particles have spread and become translucent. A group of three particles have begun to coalesce to form a single sheet of substance. ×240.

The microscope showed that the sample of dust contained particles up to thirty microns in diameter. A micro-scalpel was pressed on a cover-glass near a selected particle and the effect was watched. As the pressure was increased there came a point at which the particle collapsed into smaller particles which under continued pressure spread and coalesced into a brown patch. Under further pressure the patch spread and became correspondingly lighter in colour and, when about 0·1 micron in thickness, broke into smaller pieces, and then disintegrated into a cloud of fine particles. The accompanying illustrations show the same field of a dry mount of some coal dust of the Swallow Wood seam, a coking coal, before and after it had been crushed on the slide. The particles have all spread and become translucent, and three of them in the centre of the field have begun to coalesce.

The effects of crushing vary considerably according to the type of coal, but in general it seems that coal can behave as a plastic substance. Even anthracites, which hitherto have been obtained only as opaque even in the thinnest section, have become translucent under the simple manipulation described. The observations will be published in more detail elsewhere.

R. G. H. B. BODDY.

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Dec. 9.

Development of Penicillium on the Cut Surfaces of Certain Vegetables

WHILE making certain experiments designed to test the efficacy of various fungicides we encountered an interesting phenomenon. We noted that when the cut surfaces of potato tubers were dipped momentarily in a 2½ per cent solution of copper sulphate, Penicillium developed copiously on these cut surfaces within five days if they were kept under moist conditions, but similar untreated surfaces were uncontaminated by this or any other fungus. Further, cut surfaces of sugar-beet, turnip, Jerusalem artichoke, carrot and onion reacted similarly, although growth was less noticeable on carrot; here also untreated cut surfaces did not readily develop fungal growth.

As the effect was so striking the matter was explored further, and a similar reaction was found to occur when solutions or suspensions of other copper salts were used, namely, the acetate, chloride, nitrate, carbonate, chromate, formate and salicilate, also copper potassium sulphate and copper ammonium sulphate. With potato tubers, and when using copper sulphate, discoloration of the tissues preceded Penicillium development. It was noted, however, that with concentrations of copper sulphate below one per cent, Penicillium had not developed after seven days although discoloration had developed at concentrations as low as one in four hundred. As it was of interest to determine if this reaction could be produced with solutions or suspensions of other metallic salts, a number of these were tested, namely, the nitrates of barium, bismuth, calcium, cobalt, iron, lead, magnesium, mercury, nickel, potassium, silver, sodium, strontium and zinc. A marked and early growth of Penicillium occurred only when the cut surfaces were treated with the cobalt salt although it developed at a later date and to a much lesser extent with nickel and iron; very slight growth was noted after treatment with mercury.

A detailed account of these observations will be communicated elsewhere.

W. A. R. DILLON WESTON.
R. ERIC TAYLOR.

School of Agriculture,
Cambridge.
Dec. 8.

Effect of Parental Feeding on the Rate of Development and Mortality of *Tribolium destructor* Uyttenboorgaart (Coleoptera, Tenebrionidæ)

THE object of these experiments was to show the effect, on the rate of development and mortality of offspring, of feeding their parents on flour of different extractions. All experiments were carried out under the same conditions (apart from the food used), which were as follows:

Newly emerged first instar larvæ of *Tribolium destructor* (from eggs laid about 200 days after the first oviposition of the female) were put, in fours, in open 3 in. × 1 in. glass tubes; in a dark incubator; at 25° C. ($\pm \frac{1}{2}$° C.); and at a humidity of 50–60 per cent R.H. (usually about 56 per cent R.H.).

The two kinds of flour used, 85 per cent (National Wheatmeal) and 60 per cent (High Grade White Flour), were kindly provided by the Research Association of British Flour Millers, from a single sample of grain. The food was kept in the incubator, until it had reached equilibrium with the temperature and humidity, before being used; and an ample quantity (about 2 gm. per larva) was provided at the beginning of the experiments, for the full period of development, so contamination by fæces was negligible. The individuals were only examined at or near the pupal stage, and were treated very gently, so handling was inconsiderable.

In all experiments at least a hundred individuals were used, and no results, however extreme, were omitted in calculating the averages. The sexes were noted, but since they show no significant difference in length of period of development, males and females are not separated in the summaries. All figures given in the summaries show the average number of days taken from the emergence of the first instar from the egg to the eclosion of the adult from the pupa.

The mortality figures include all larval, prepupal and pupal deaths, but adult viability was not investigated. The experiments where parents were fed on 85 per cent flour, and their offspring fed on 60 per cent flour, were repeated as a check and it will be seen that the results (average 44·9; standard deviation 2·1; mortality 3 per cent) approximate very closely to those obtained in the original experiment.

The results show that the rate of development of the offspring is influenced by the food on which their parents are fed. Thus, whether larvæ are fed on 60 per cent flour or on 85 per cent flour, they develop more rapidly when their parents have been fed on 85 per cent flour than when their parents have been fed on 60 per cent flour. Indeed, so strong is the effect of parental food that larvæ develop more quickly on 60 per cent flour, if their parents have been fed on 85 per cent flour, than they do on 85 per cent flour if their parents have been fed on 60 per cent flour. Applying Fisher's t test to these results, the differences between larvæ fed on the same foods, but whose parents were fed differently, are highly significant ($P<0{\cdot}01$). The difference between the larvæ which were fed on 60 per cent and 85 per cent (parents 60 per cent) is also significant ($P<0{\cdot}01$). The difference between the larvæ whose parents were fed on 85 per cent is not significant (P between 0·1 and 0·05).

Similar conclusions are reached from a study of the mortality figures. These again show the advantage to the offspring of parents fed on 85 per cent flour, whether the offspring themselves be fed on 85 per cent or 60 per cent flour. The figures also show that the food of the parent has a greater effect on mortality than has the food of the larvæ.

These experiments are part of some work done voluntarily for the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, and I wish to express my thanks to Mr. G. V. B. Herford and Dr. O. W. Richards for their readiness at all times to give help and advice.

RATE OF DEVELOPMENT

	Parents fed on 85%		Parents fed on 60%	
	Average	Standard Deviation	Average	Standard Deviation
Larvæ reared on 60%	44·4	±2·4	52·4	±5·3
Larvæ reared on 85%	43·9	±1·7	48·2	±3·8

MORTALITY

Parents fed on	85%	60%
Larvæ fed on 85%	7%	39%
Larvæ fed on 60%	14%	41%

Biology Department,
College of Technology,
Leicester.
Nov. 19.

J. M. REYNOLDS.

Discoveries by Accident

PROF. RUSS will find it interesting, I think, to refer to the 1929 May Lecture of the Institute of Metals which was delivered by Sir Oliver Lodge on the theme of "States of Mind which Make and Miss Discoveries".

"It is instructive," said Sir Oliver Lodge, "to realise the state of mind which misses a discovery as well as, what is more commonly attended to, the more admirable state of mind which succeeds." Many experimenters had opportunities as good as Röntgen's to observe the X-rays which were generated in their laboratories. Sir Oliver Lodge cited the case of Rev. Frederick Smith who, on finding that the plates wrapped in a box near a tube were fogged, was—so to speak—annoyed at this disturbance of his experiments, and kept the plates out of the way.

I have always remembered the fascinating manner in which Sir Oliver Lodge elaborated the philosophy of the inventive mind in this lecture; and I have remained convinced that the "admirable state of mind" which led Röntgen to follow up his observation fully entitles him to recognition as the *discoverer* of X-rays.

J. C. CHASTON.

Johnson, Matthey and Co., Ltd.,
Research Laboratories,
Exhibition Grounds,
Wembley.

RESEARCH ITEMS

Wooden Implements of a Primitive Tribe

An interesting light is thrown on the possible methods of early man by a description of modern stone-age man in the Musgrave Ranges of South Australia ("An Unrecorded Method of Manufacturing Wooden Implements by Simple Stone Tools." By C. B. Mountford. *Trans. Roy. Soc. South Australia*, 65, (2); 1941). The Pitjendadjara tribe is one of the most primitive in Australia, and among their few possessions are spear-throwers fitted with an adze stone on the end, and spears. The manufacturing process of the spear-thrower is described by the author. The tools used were natural stones selected for possessing some sort of cutting edge, but undressed. With these as the sole instruments a shaped slab was stripped from a small Mulga tree—a slow and laborious process—and the bark removed before it was taken to the camp. There the shaping and finishing took place with the help of smaller, but still unflaked, stones and finally with the aid of the adze stone of a finished spear-thrower. The adze stones themselves were merely flakes of chert with good cutting edges and were stuck into the handle end of the spear-thrower with spinifex gum warmed over a fire. When these stones became blunted with use there were some attempts to create a fresh cutting edge by tapping them with the wooden blade of a spear until miniature flakes were broken off. The throwing peg was made of wood and attached by spinifex gum to the tip of the spear-thrower and then securely bound with tendon. The stones used in these processes were all discarded and left behind, when finished with; and as such stones bear no recognizable trace of their use by human beings, a material culture such as that of the Pitjendadjara tribe might well become extinct without leaving any trace of its existence.

Pantothenic Acid in Tissue Growth

For their growth, many pathogenic organisms require pantothenate, of which there is usually more than enough in animal tissues. On the hypothesis that pantothenic acid takes part in enzyme reactions the progress of which is necessary to growth, H. McIlwain (*Biochem. J.*, 36, 417; 1942) postulates that pantothenate, to be used by an organism, combines with a particular part of it. By analogy with other enzyme inhibitors, it was expected that compounds structurally related to pantothenate might displace it from these enzymes and prevent their functioning. The inhibitions recorded for pantoyltaurine, pantoyltauramide and homopantoyltaurine show that their actions are clearly related to pantothenate and their quantitative interactions were of the character of competitive enzyme inhibitions, probably due to an analogue occupying the active centres to which pantothenate must have access for normal activity. These analogues had less affinity for the enzymes than had pantothenate and needed to be present in many times its concentration to prevent growth. Only organisms needing pantothenate were found susceptible to these compounds. Other analogues were inhibitory to several organisms not needing added pantothenate. Thus, exacting strains of *Cl. diphtheriæ* are inhibited, but not those needing added pantothenate. Such analogues may also act by interfering with pantothenate metabolism, since the latter organisms synthesized the compound.

Fishes of the Genus Bothriolepis

Walter Gross, in his work "Die Bothriolepis-Arten der Cellulosa-Mergel Lettlands" (*Kungl. Svenska Vetenskapsakademiens Handlingar*. Tredje Serien. 19, No. 5; 1941), describes in great detail two species of Bothriolepis from the Upper Devonian marls, Kokenhusen, Lettland. One of these, *B. cellulosa* (Pander), is already known; the second, *B. tuberculata*, is new and described here for the first time. Remains of both species occur in the same locality and in considerable quantity, chiefly consisting of the separate bony plates and jointed pectoral fins characteristic of these ancient fishes. The pectoral appendage, which is covered by hexagonal plates, is regarded by recent workers, including the present author, as a true pectoral fin. He suggests the possibility that the fishes here described may be only sexual forms of the same species, *B. cellulosa* being the female and *B. tuberculata* the male. The plates and fins differ in shape and markings and are beautifully preserved. The paper is illustrated by excellent photographs occupying twenty plates.

Sex Ratio in Cattle

It is sometimes believed by cattle breeders that one sire tends to produce a higher proportion of females than another, and that the sex ratio of the progeny is influenced by the age of the sire. J. W. Gowen (*J. Hered.*, 33, 299–304; 1942) has analysed the data from 3,559 births and reaches the conclusion that neither surmise is correct. Sex determination in families of cattle is at random in most instances, and the age of the sire or dam does not materially affect the sex of its progeny.

Effect of X-rays on *Drosophila pseudo-obscura*

The haploid chromosome complement of *D. pseudo-obscura* consists of a V-shaped *X*-chromosome, three rod-shaped and one small dot-like chromosomes. Nevertheless, genetical evidence indicates that the arms of the chromosomes are phylogenetically related to those of *D. melanogaster*. P. C. Koller and I. A. R. S. Ahmed (*J. Genetics*, 44, 53–72; 1942) and R. G. Helfer (*Genetics*, 26, 1–22; 1941) show that X-rays produce comparable results in the two species. The frequency of chromosome breaks per detectable changed sperm indicates that the same amount of ionization has similar effects in the two species. A considerable amount of data is given on the distribution and type of chromosome breaks and rearrangements found in X-ray induced and normal material.

Cytology of *Rhoeo discolor* and Tradescantia

P. N. Bhaduri (*J. Genetics*, 44, 73–127; 1942) has used the new cytological technique of Semmens and Bhaduri to analyse the nucleoli and secondary constrictions in *Rhoeo discolor* and several species of Tradescantia. As a result he has found that the twelve chromosomes of *R. discolor* which are derived from previous segmental interchanges show morphological differences, that non-homologous segments may be identified in otherwise homologous chromosomes, and that the number of nucleoli are increased by such interchange as well as by polyploidy. *R. discolor*, a structural hybrid diploid, has eight nucleoli in place of the more usual two in non-hybrid material. Similarly, the number of nucleoli and sat-chromosomes is higher in the species of

Tradescantia than would be expected. The size and relationships of the nucleoli are also of importance. Two homologous sat-chromosomes will give similar nucleoli, whereas nucleoli derived from non-homologous parts will probably differ. The author concludes from his analysis of *T. virginana* (4*n*) that it is not an autotetraploid, but is of hybrid origin.

Spectrophotometric Estimation of Vitamin A

J. I. M. Jones and R. T. M. Haines discussed "The Spectrophotometric Estimation of Vitamin A in Fish Liver Oils" at a meeting of the Society of Analysts and Other Analytical Chemists on November 4. The spectrophotometric estimation of vitamin A in low-potency fish liver oils is usually carried out on the extracted unsaponifiable matter, in order to get rid of irrelevant absorption at the characteristic wave-length of 325 mμ. It has previously been stated that no direct relation exists between the absorption so determined and that determined on the whole oil. Re-examination shows that there is a strong correlation between the two values for the same type of oil and that the difference is probably not due to irrelevant matter unless it be that such matter is always present in fixed relation to the vitamin A. Data for cod, shark, halibut and tunny liver oils show this correlation, but the nature of the correlation in cod and halibut is different from that in shark and tunny. There is evidence that the cause of the loss of absorption after saponification is not affected by wide variations in technique, but is related to the nature of the oil and may be connected with adsorption of vitamin by the soap formed during saponification.

Preparation of Deuterium Chloride

Although several methods have been published for the preparation of deuterium chloride DCl, they all have some drawbacks. H. C. Brown and C. Groot (*J. Amer. Chem. Soc.*, 64, 2223; 1942) find that by dropping deuterium oxide into excess of heated benzoyl chloride, the temperature being finally raised to the boiling point, deuterium chloride is evolved at a satisfactory rate. The product is analytically pure and the yield practically quantitative. The reaction occurs according to the equations:

$$C_6H_5COCl + D_2O = C_6H_5COOD + DCl,$$

$$C_6H_5COCl + C_6H_5COOD = (C_6H_5CO)_2O + DCl.$$

Hardness of Silver Alloys

The influence upon hardness of alloying with silver one or more elements which enter into primary substitutional solid solution has been studied by J. H. Frye, jun., and W. Hume-Rothery (*Proc. Roy. Soc.*, A, 181, 1; 1942). Accurate Meyer analyses made on annealed bars of vacuum-melted spectroscopically pure silver, assay silver, and on binary alloys of silver containing up to 5 atomic per cent of cadmium, indium, tin, antimony, zinc, aluminium, magnesium and gold show that in contradiction to the statements of some previous investigators, the ultimate Meyer hardness P_u increases as the grain size of the specimens diminishes. Reduction of the results to P_u values for one standard grain size enabled an accurate comparison to be made of the relative hardening effects of the different solutes. When these results are considered from the point of view of lattice distortion, it is shown that for a given atomic percentage of solute, the increase in P_u is proportional to the square of the lattice distortion for solutes in the same row of the Periodic Table. No simple relation was found for solutes from different rows of the Periodic Table, and for a given solute the relation between P_u and the composition is not necessarily simple. The conclusions are tested by experiments on ternary alloys, and data for copper alloys are discussed.

Diameters of Extragalactic Nebulæ

In an important note (*Proc. Nat. Acad. Sci.*, 28, 186; 1942), Dr. H. Shapley gives the results of a photometric comparison of spheroidal and spiral galaxies. It appears that, contrary to earlier indications, the open spirals with their widely extended arms are not appreciably larger than the structureless spheroidal forms. The new measurements, unlike the previous estimates, are based on precise microdensitometer readings taken on properly standardized plates, and reveal little difference in linear diameter between the various types of extragalactic nebulæ. The early suggestion that spiral arms are expelled dynamically from the nucleus during evolutionary development would thus seem to be premature: such features are to be regarded rather as due to a change of structure well within the main body of the system. If, as may well be, the direction of evolution is from spiral to spheroidal, then the condensed arms, supergiant stars and diffuse nebulosities of a spiral system must eventually merge into the featureless smooth form of the typical spheroidal galaxy by a process of internal readjustment and not by contraction.

Transit of Mercury on Nov. 11-12, 1940

Visual observations of this transit collected from Australia, New Zealand, Japan, the Philippines, and North and South America have been reduced and discussed by G. M. Clemence and G. C. Whittaker (*Pub. U.S. Naval Obs.*, 15, Part II, 1942). Altogether two hundred observations are combined in various ways to obtain the universal time of geocentric contacts II and III. The residuals from the indiscriminate mean are not distributed according to the normal error law, large values occurring too frequently, and the effect of excluding certain of the observations with large residuals is examined. Probable errors of ± 1·0 sec. and ± 1·2 sec. are assigned to the times of contacts II and III respectively. The adopted observed times *O* are then compared with the theoretical values *C* obtained after correcting the Tables of the Sun and Mercury for small errors of the elements. The so-called "fluctuations" *O*—*C* which result are caused by irregularities in the rotation of the earth, leading to errors in the reckoning of astronomical time. The fluctuation at contact II is 43·1 sec., while the value at contact III is 25·5 sec., the weighted mean of 36·1 sec. agreeing well with the 35·3 sec. obtained for the time of transit from lunar observations. The discordance between the two contacts indicates that the duration of the transit was 18 sec. less than the expected value, and consideration of the interval between contacts III and IV confirms this discordance. It may be attributed partially to physiological and psychological factors attending a difficult observation of this kind, but no completely satisfactory explanation can be given at present. The observations taken as a whole provide a welcome independent check on the results obtained by observations of the moon.

SCIENCE AND THE UNITED NATIONS

THE Conference on "Scientists of the United Nations and the War Effort" convened by the Association of Scientific Workers on December 5–6 covered a very wide field. Men of science must leave no doubt about their attitude to the ideologies and practices of the Nazis and Fascists. There is no question about the importance attached to science by the Nazis. Dr. Kuczynski, the famous statistician, speaking of Germany, told of the prestige there enjoyed by men of science. Speakers from Norway, Belgium and Denmark spoke of the attempts of the Nazis to impose their ideology through the universities and schools. These speakers and a Greek man of science, whose name was not published, also told of the resistance which the staffs of universities and schools are making. In Norway, for example, the universities have refused to do anything that was not legal before the invasion; the school teachers have resisted Nazi orders although one in five has been sent to a concentration camp.

The Norwegians had to face a clear-cut issue and made their choice; in Germany, as Dr. Kuczynski related, many men of science were not deliberate supporters of the Nazi regime; but, because they hoped to continue their work without interfering in public affairs, they have become active assistants of the Nazis. This leads to a point made by Dr. G. Lewi, formerly secretary-general of the Federation of Czechoslovak Chemical Industries, deputy chairman of the Association of Czechoslovak Scientists and Technicians in Great Britain, who said that men of science, on whose work the whole structure of modern civilization is built, may not remain aloof from running that civilization. If they do, they will compromise with evil and find themselves committed to the wrong side.

The part played by the people of the occupied countries in the development of science was stressed by many of the speakers. Austria, as Dr. Stock pointed out, has produced six winners of Nobel prizes for science—one per million of population; the three living prize-winners left the country after the Anschluss. Mr. Pevtich, press attaché of the Yugoslav Embassy, told of the numerous Yugoslavs who have made conspicuous contributions to science. Dr. Frankenstein, professor of international law at The Hague, spoke of the debt which German science owes to Jews, of the valuable contributions to the Allied cause by Jews in Palestine in making instruments of precision and of the chemical work of Dr. Weissman, the Zionist leader. During the civil war in Spain the encouragement given to science by the Republicans had borne fruit in the development of an extensive blood transfusion service, the first of its kind, and a new method of treating wounds. In China the growth of science has been checked by the Japanese invasion, but continues and has been concentrated mainly on problems, such as those of nutrition and agriculture, that will be involved in reconstruction.

In the selection of a person for any position, two criteria only should be considered: he should be whole-heartedly opposed to Nazism and Fascism, and he should be the best qualified to do the work involved. In a time of total war we cannot take irrelevant matters such as nationality into account. Prof. Cassin, legal advisor to General de Gaulle, was able to claim that all men of science among the Fighting French, both in Great Britain and the United States, are able to play their part to the full in the common struggle. Miss Simpson, secretary of the Society for the Protection of Science and Learning, told of the work that the Society has done, first in finding positions for refugees and later in securing the release of men of science who were interned in Great Britain; only twelve out of 526 appeals for release have been refused. Mr. T. H. Brind, of the International Labour Branch of the Ministry of Labour and National Service, spoke of the efforts made by his branch to overcome the difficulties that arise in getting full employment for alien scientific workers. However, several speakers expressed the view that adjustment is not complete. Even if no obstacles are raised by any Government Department there remains the prejudice of individual employers, which is likely to persist so long as the most ardent opponents of Nazism are labelled "enemy aliens". If the services of distinguished men of science are not used, agitation can be made and the matter is put right. But there is no machinery for redress in such a case as that of a young man who had served with the Pioneers in France, had distinguished himself in a course of training in making instruments of precision, but was then not employed on the work to which he had been trained; for fear of military discipline, he cannot let his name be used. Also, until the men of science who supported the Spanish Republic and are now in North Africa are freed, we are not using all the scientific personnel at our disposal.

Prof. S. Chapman discussed the use of scientific personnel in the War. He suggested that there is a danger of overlapping of work and that this might be avoided if a central directory be set up from which a responsible person could learn whether any question which he proposed to study was already under investigation.

At the end of the Conference the following resolution was passed:

"We, scientific workers from countries menaced or oppressed by Nazi-Germany and her Allies, assembled in London in a conference, have resolved on the following.

"We accuse Germany and her Allies of systematically destroying the scientific institutions and exterminating the scientists of the occupied countries, as an integral part of her warfare, with the intention of strangling the scientific life and culture of those countries.

"We pledge ourselves to give our best in the fight against such monstrous barbarism, and to answer to-day each new crime with a further intensification of our efforts on behalf of the suffering peoples of the world by striking harder against these enemies of mankind.

"We appeal to our colleagues on the Continent and throughout the world to increase their efforts of which we hear again and again with emotion and pride against the oppressors. Only deeds count to-day and this applies equally to the freedom loving scientists on the Continent and to ourselves.

"We warn those who to-day willingly work for our oppressors that retribution is near.

"We express our satisfaction that a very considerable number of foreign scientific workers have already found work in this country which enables them to use all their knowledge and training in the common war effort, and hope that soon all of us will have found a place where the best use can be made of our experience and willingness to serve.

"We shall work to ensure that the co-operation among the scientists of so many countries which is developing to-day shall be a model for the integration of the world scientific effort after victory has been won."

NEWTONIANISM AND SCHOLASTICISM

IN his presidential address to the annual statutory meeting of the Royal Society of Edinburgh, under the title "Aristotle, Newton, Einstein", Prof. E. T. Whittaker compared the modern revolution in physics, by which the ideas of relativity and the quantum theory have displaced those of Newtonian mechanics, with the revolution in the seventeenth century when Newtonian mechanics triumphed at the expense of Aristotelian Scholasticism. His main thesis was that the Scholastic ideas which were destroyed by the movement of which the work of Newton marked the culmination, were a perverted form of the true philosophy of Aristotle, and that the modern outlook represents a return—or at least a tendency to return—to the true Aristotelian outlook. The work of Tycho and Kepler disproved and overthrew the existing Scholastic cosmology, but it contained nothing inherently irreconcilable with the Scholastic metaphysics and might conceivably have been absorbed into the philosophy of the Schoolmen by a peaceful and conservative revolution. Actually, however, what was essentially a new metaphysic was introduced. The basic postulate of the Newtonian mechanics, in which it differed sharply from Scholasticism, was the fundamental and independent status accorded to space and time. Persistence of bodies in time and their displacement in space became the concepts to which everything in the external world had to be reduced, and bodies moved in obedience to the forces which acted on them in space and time.

A partial return to the Aristotelian view that all change is a transition between a state which is potential and a state which is actual came with the doctrine of the conservation of energy, in which force is ignored and a change is represented by a transition between potential and other forms of energy; and this tendency has more recently been emphasized by the quantum mechanics, in which the operator corresponding to classical potential energy is closely akin to the Aristotelian concept of potency. The introduction of 'minimum' principles, which culminated in 1915 when Hilbert introduced a 'world function' which determines all physical events in the universe by the condition that its integral taken over the whole of space-time is a minimum, marked another drift back to Aristotelianism, since such principles, like Aristotle's, are essentially teleological. General relativity, according to which gravitation represents a continual effort of the universe to straighten itself out, is so completely teleological that it would certainly have delighted the hearts of the Schoolmen. A free particle, in relativity theory, moves in a path determined solely by the curvature-properties of space; it is, as the Aristotelians would say, *in potency* with regard to space.

The importance of quantum theory from this point of view is that it shows that there are events in the physical world which cannot be represented on the background of space and time. Space and time must accordingly be deposed from the dominant position which they held in Newtonianism. We must begin not with space and time but with events; and the atom, which has a potency of various states, is correlated to the states as potency is to act. It endures as the atom, while it takes different states in succession. Thus, the proton and neutron are now regarded as two 'states' of a single entity, often called a 'heavy particle'. In Aristotelian terms, the heavy particle would be 'matter' and its determinations as a neutron or proton would be its two possible 'forms'. Matter is correlated to form as potency to act.

The peculiarities of modern statistical theory also are conveniently expressible in Aristotelian language. An electron can freely interchange its recognizability with other electrons; it has no sameness of being, no proper identity, no separate history. Its selfhood is merged in an electronhood which it shares with all other electrons, and which is correlated with it as potency to act. This reopens the question which engaged so much attention in the Middle Ages, regarding the nature of *universals*, or general terms, which represent the common basis of a class of individual objects.

Prof. Whittaker considers that these tendencies of modern physics should lead to more intercourse and mutual understanding between men of science and philosophers; for of all types of philosophy, the Aristotelian-Scholastic is, in its principles, the most congenial to the scientific mind. It is in a sense true that correct, even if in some respects limited, knowledge regarding physics can be combined with any view whatever on the fundamental questions of being and reality, but the effect of such segregated thinking has been to make science a departmental affair, having no influence on life and thought except indirectly through its applications. At the present time there is a movement in scientific circles aiming at securing for science a greater influence on human affairs, and even calling for a refounding of civilization on a scientific basis; but its advocates do not always understand that, as a necessary condition for the possibility of such a reform, science must be reintegrated into a unity with philosophy and religion.

ESKIMO CRANIOLOGY

THE first part of a catalogue of human crania in the United States National Museum was issued in 1924. It gave measurements of four short series from parts of Alaska. Since then the Smithsonian Institution has sent eighteen anthropological expeditions to the country, and the United States National Museum now has 2,200 Eskimo skulls, many of which are accompanied by the rest of the skeleton. The latest part of the catalogue to be issued* provides individual measurements of the whole collection of skulls, including a number for which data had been published previously. Dr. Hrdlička, the doyen of American physical anthropologists, has thus made another substantial contribution to the long list of his achievements in collecting, describing and analysing the material of his science.

For each specimen nineteen absolute measurements and twelve measurements of shape (indices and angles) are given. The set of characters which should be recorded in craniometric studies has not been standardized; and a fuller list has frequently been used. The aim in all cases has been to give a general description in metrical terms of the skull as a whole and of all its principal parts, such as the brain-box; orbits, nasal aperture and so on. Owing to the lack of international agreement, the same character has sometimes been measured by different observers in two or more ways, thus making the data less useful than they might have been with the same expenditure of labour. In spite of these drawbacks there is extensive comparative material for nearly all the measurements given in the Eskimo catalogue.

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* *Proc. U.S. Nat. Mus.*, 91, 169–429 (1942). "Catalog of Human Crania in the United States National Museum Collections: Eskimo in General", by Aleš Hrdlička. (Washington, D.C.: Gov. Printing Office.)

Scientific workers other than anthropologists are unlikely to have any just appreciation of the scope and uses of such records. There has been no convenient digest of them, and the problems of racial history which they should elucidate apparently remain obscure. All countries in the world are represented by well-described series of skulls, and those long enough to give a reasonably good representation of a population—series comprising fifty or more fairly complete specimens of one sex, say—range from about 5000 B.C. to modern times. The peoples that have been best described in this way are the ancient Egyptian (about 5,000 specimens), Eskimo (Hrdlička, and Fürst and Hansen, 3,000), British (3,000) and Norwegian (Schreiner, 2,500). The number of Eskimos is now considerably greater than that for all other American peoples put together, if artificially deformed skulls are left out of account. It is fortunate for anthropologists that the arctic population did not adopt the unnatural practice which was common in most other parts of the continent.

Study of differences between the physical characters of Eskimo communities may be expected to throw light on the problem of the peopling of America. Dr. Hrdlička has discussed this matter at length elsewhere and he refers to it briefly in the notes appended to his new catalogue. Considered as a whole, the Eskimo population has long been recognized to be of a specialized type, as are the isolated human populations found in other remote parts of the world. The typical skull is characterized by a median ridge on the vault, and the great breadth and large size of the facial skeleton are other striking peculiarities. In spite of the basic similarity of the type throughout the population, average measurements given for local groups reveal clear differences in some characters. The cephalic index in particular makes many distinctions which are markedly significant. In general it is higher in the west and lower in Greenland, though the lowest value is for an Alaskan series which is also distinguished by being the oldest. It is assumed that the group must have spread in relatively recent times on account of linguistic and cultural similarities over all its present region. The inference is that the mixture or changes which led to physical diversity "took place not on the American continent but well back in the original habitat of the people, which doubtless was Arctic Asia". Although the evidence is fairly extensive already, it is necessary to ask for more—relating particularly to older Eskimo and related peoples—before skeletal material can be expected to reveal clearly the racial history of Eskimos in America. In considering such questions the need for fuller knowledge is constantly felt.

The cranial measurements given in the catalogue are not analysed statistically there, but they might be used to illustrate the essential nature of all modern populations of *Homo sapiens*. Variation within any subgroup is found to be very considerable, the range for any metrical character being not less than half the range for the total species. The more isolated populations, such as the Eskimo, are found to be only slightly less variable than those of Europe. Gradations within the culturally defined group, and also between it and neighbouring groups, are always observed. Anthropological data supply innumerable examples of character-gradients (or 'clines' as Huxley has recently named them), and it is owing chiefly to their existence that no agreement has yet been reached regarding the way in which races of modern man can best be defined.

Geneticists have hitherto taken little interest in polygenic characters such as cranial measurements, and it has not been shown that any skeletal characters which anthropologists might use for their special purpose are other than polygenic. A few characters of living people controlled by small numbers of genes are known, but there can be little hope of disclosing any details of the course of racial history by treating them alone. Evidence of a palæontological kind seems to be essential for that purpose. It may be anticipated that data such as those placed on record by Dr. Hrdlička will be used by future generations of anthropologists, even if they treat them by methods as yet unimagined.

G. M. MORANT.

FORTHCOMING EVENTS

Saturday, January 9

ASSOCIATION OF SCIENTIFIC WORKERS (in the Lecture Theatre of the London School of Hygiene, Keppel Street, London, W.C.1), at 2.15 p.m.—Conference on Problems connected with the Organisation, Application and Personnel of the Medical Sciences. (Chairman: Dr. D. McClean.)

Monday, January 11

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Discussion on Flying Maps.

Tuesday, January 12

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 2 p.m.—Sir Charles G. Darwin, F.R.S.: "The Extreme Properties of Matter" (James Forrest Lecture).

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (JOINT MEETING WITH THE INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. H. Ter Meulen: "The Solvent Extraction of Lubricating Oils".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W.C.2), at 5 p.m.—Mr. H. C. Weston: "Proposals for a New Lighting Code".

Wednesday, January 13

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Anthony Hurd: "Agriculture To-day and To-morrow", 3: "Research and the Farmer".

Thursday, January 14

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Mr. F. H. Cotton: "Synthetic Rubbers".

Friday, January 15

ROYAL SOCIETY OF ARTS (JOINT MEETING OF THE INDIA AND BURMA SECTION WITH THE EAST INDIA ASSOCIATION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Maurice Yeatts: "The Indian Census of 1941".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MECHANICAL ENGINEERING in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (January 17).

DIRECTOR of the National Froebel Foundation—The Secretary, National Froebel Foundation, 2 Manchester Square, London, W.1 (February 27).

CHAIR OF MINING—The Secretary, the University, Edmund Street, Birmingham, 3 (March 1).

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield.

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COAL CONSERVATION IN GREAT BRITAIN

IT would be difficult to overstress the importance of making the maximum use of the available coal in Great Britain; our survival as a first-class nation may indeed come to depend on the answers we give to some of the fundamental questions concerning the proper use of coal. Individually, they are well understood, and there is no great divergence of opinion as to the facts. Collectively, there is a lack of agreement as to policy, and a strange and fatal apathy on the part of Ministries and the fuel industries. This lack of understanding in the past has in no small measure brought about the present unfortunate and serious state of affairs, where confessedly we are unable to supply the consumer with our only native mineral, albeit the demand is less than in peace-time.

Certain aspects of the problems were referred to by Mr. E. V. Evans, the present technical leader of the gas industry, at a meeting of the Fuel Luncheon Club held on December 17 last. It is perhaps worth while directing attention to them, as the subject above all needs impartial discussion on a platform free from the sectional interests of the various coal-using industries.

Britain's world predominant position was built on coal; until the War of 1914–18 both coal and transport were cheap and only the very few were concerned to use coal economically. Bad habits persist, and it is a safe guess that at least 20 per cent of the coal used by industry in Great Britain in 1939 could have been saved by attention to methods of fuel economy. A committee of fuel technologists under Dr. E. S. Grumell is known to be at work to effect this saving.

The question before the public is how they shall obtain the heat, light and power they need in their daily life: from raw coal, gas or electricity? The three forms have been long competitive for the favours of the householder, and the tempting prices charged are not always fair. There can be no justification for price structures that put a tax on consumers who *must* use the commodity in order to subsidize adventure in markets that, in themselves, are uneconomic.

Surely, the various branches of the fuel industry should become complementary parts of one whole. This is the essence of the problem of co-ordination, and the solution can only be achieved by the findings of impartial judgment, sifting and balancing the advice of experts. The fuel industries themselves should be preparing for such comprehensive co-operation, which indeed has been largely achieved in certain American cities, but so far there is no sign of such vision in Great Britain.

The householder of the future will require to use both gas and electricity and perhaps some solid fuel for water and space heating. The old-fashioned coal fire grate, using raw coal and sending all the tar products and most of the heat up the chimney, is an anachronism. Surely it should be forbidden as a wasteful apparatus under the new fuel order announced on December 28, for only some 20–25 per cent of the heat in the coal reaches the room. It is responsible also for the smoke pall, for fogs and for the decay of stonework, metal and textiles. Until November 11 last, many of the present generation had never seen a London fog and realized what burning raw coal involved. It is criminal also to waste the raw hydrocarbon material present in coal tar. Great Britain has no native oil, a handicap the extent of which we have yet to realize, and it should be insisted that every ounce of tar is recovered and used as the raw material for motor-fuel and chemical industries. Perhaps the day may come when all coal, whether used for domestic or industrial purposes or for making electricity, is carbonized before use. Petroleum may well become scarce or we, as a nation, so poor that we cannot afford to buy it.

Light will be supplied by the electrical industry and should become cheaper, better and capable of decorative development as the lamp improves. Power applied to small units is also a matter for electricity. The cooking and individual heating load is claimed by gas, and the share that electricity is to take requires settlement. Water heating and central heating are best done with coke, for which they provide a valuable outlet. Both gas and electricity claim to heat small quantities of water.

It is quite clear that from the scientific and national point of view the burning of raw coal by the domestic consumer should be discouraged: a point not previously mentioned is that the transport and delivery of solid fuel to each household and the collection of ashes are wasteful factors. Rubber, petrol and man-power are scarce now, but however plentiful they may become they should not be wasted.

Both gas and electricity are 'on tap' in the home; the onus of maintaining an efficient load factor is thrown on the companies. The annual hourly load factor of the gas industry, that is, the relation to the plant required to meet the maximum demand, is of the order of 17–20 per cent. Fortunately, the provision of the gasholder makes it possible to even out the load to 50–60 per cent. The load factor of the electricity companies is 30–35 per cent: they can store steam but not electricity.

Both industries seek to obtain off-peak loads, presumably each from the other. Both have made great strides in economic production. Since 1916 the consumption of coal per horse-power hour for power has dropped from 5–7 lb. to 1¼ lb. The gas industry has increased the thermal efficiency of its process to about 80 per cent and increased the total amount of heat supplied by 13 per cent in the last eighteen years in spite of competition by the electrical industry. The replacement of the coal range by the gas cooker has involved a saving of some 15 million tons of coal a year, besides an enormous relief to the housewife.

As regards the future, the coal industry is endeavouring to design appliances that shall burn coal without smoke; the gas industry is preparing to demonstrate how greatly the interests of the nation and of the consumer will be served by the extended use of gas for space heating and water heating; and the electrical industry, always growing more efficient, is interested to take over such proportion of these loads as can be supplied remuneratively.

Some measure of guidance and of collaboration is necessary. In this, coal conservation must be included as the predominant factor. The appliances and methods that were in common use before the War and are in use to-day show striking differences in the amount of coal that has to be consumed to give *equivalent service* by different methods. According to Mr. Evans, for most domestic uses gaseous fuel shows a saving of some 40 per cent compared with either raw coal or electricity. Clearly we must try to establish and work to a sane national fuel policy, so that the resources of material and man-power in Great Britain are not wasted.

MEDICINE FOR PHILOSOPHERS

Physics and Philosophy

By Sir James Jeans. Pp. vii+222. (Cambridge: At the University Press, 1942.) 8*s*. 6*d*. net.

IF Sir James Jeans finds difficulty in defining philosophy (p. 16), there is no doubt of his qualifications for the task. Emerson, in his essay on Plato as a "representative man", defines philosophy as the account which the human mind gives to itself of the constitution of the world. It has been given to Jeans to participate effectively in our quest for the "constitution of the world"; as physicist, as mathematician, as astronomer, as cosmologist, he has opened windows on Nature—on the origins of planetary, stellar and nebular masses and on the interplay of matter and radiation. Now he attempts what he has earned the right to do: he speaks to us his account of the nature of reality, his views on materialism and what he calls mentalism, on determinism and free-will.

If we define the aim of science, including all utilitarian and humanitarian applications, as the endeavour to live the good life and to see into the mind of God, then at least part of that aim is realized when a mature man of science and thinker approaches the fundamental problems of philosophy by the path of mathematics and physics; and in fact without that background the discussion of philosophical problems tends to remain verbal and scholastic. It is, of course, sadly true that whereas we have had our poet and our man of science with the unmistakable characters of universality and agelessness—our Shakespeare and our Newton: we still await a modern *universal* philosopher, a thinker fully equipped as mathematician, physicist, biologist and psychologist, a new Aristotle. Sir James Jeans modestly states that his acquaintance with philosophy is simply that of an intruder, without any authority on questions of pure philosophy. Nevertheless he gives the pure philosopher a good deal to think about.

Perhaps the pure philosopher will wince most under the thrusts which Jeans gives him in the chapter entitled "The Two Voices of Science and Philosophy". While much of the book, as a survey of recent physical thought, is necessarily not new, in these sections Jeans has something vivid, pertinent and new to say to philosophers; and they may be considered as constituting Jeans's riposte (and an effective riposte they are) to the criticisms which have been made on him by professional philosophers. He analyses the relation between science and philosophy in terms of differences of language, differences of idiom and differences of method. His main reason for the differences of language is that philosophy "tends to think in terms of facts as they are revealed by our primitive senses, while science thinks of them as they are revealed by instruments of precision"; he illustrates this, in more than one part of the book, by a most engaging account of the differences between what the philosopher thinks he means by 'red' and 'redness' and what the physicist means.

Jeans is still more to the point in his account of the philosopher's *idiom*. He gives three types of this. First, "the philosopher usually thinks in terms of qualities, the scientific man in terms of quantities". Secondly, he accuses philosophers of "depicting the world entirely in black and white, and so ignoring all the half-tones, gradualness and vagueness which figure so prominently in our experience of the actual world", and illustrates by the law of the excluded middle, which has so devastated logic. (A pure mathematician might, however, have something to criticize in Jeans's statement that a fallacy lies in the supposition that quantities can be sharply divided into finite and not-finite.) Lastly, he accuses the philosopher of over-simplification. I confess I found myself uneasy on this point, for though Jeans is happy in his examples, as usual, he must be well aware that progress in a *scientific* problem nearly always attends on the right kind of simplification and idealization; in fact, it may be said that the role of mathematical physics is to make self-consistent statements about non-existent entities. As regards differences of method, Jeans criticizes the philosopher as being more *atomistic* in his thought than the scientific man—treating time as a collection of instants, and so on. Jeans is not, however, fortunate in his example of the scientific man seeing Nature as a theatre of *continuous* change, "as a *cinematograph* show rather than as a series of magic-lantern slides"; indeed, he later dwells on the snare of mistaking apparent continuity for genuine continuity, instancing the staircase at 45° with very small steps, which will always support a particle in equilibrium.

On the science of philosophy, Jeans is good; on the philosophy of science he is less good. In a sentence which I do not understand, Jeans says: "The métier of the philosopher is to synthesize and explain facts already known". Does Jeans exclude from the philosopher's province that of *criticism*? It seems to me that one of the principal differences between philosophy and science is that the problems of philosophy are permanent whereas the philosophical conclusions of science are ephemeral. Recently, indeed, physics has changed almost unrecognizably every twenty years or so, not only in the scope of its content but also in its conclusions about itself. What right have we to regard the present position in physics with the complacency which Jeans almost habitually assumes towards it? He attributes to it a degree of perfectibility which philosophical history teaches can be assigned to no construction of the human mind. In his concluding sentence he admits that the quest, and not the knowledge itself, gives the greater interest to thought; but where, in this volume, is that ceaseless interrogation of current conclusions which it should be the aim of a critical philosophy to conduct?

I fear that professional philosophers could find much to criticize in the current philosophy of physics, if it were wholly as given in this volume. A few instances are all I have space for.

First of all, for the honour of nineteenth century science, I must correct an unexpected slip on Jeans's part. He says that the mere permanence of the atom showed the need for a revision of the classical mechanics, for (p. 124) "the constants known to the classical mechanics cannot be combined to form a length at all"; surely e, m and c combine to give e^2/mc^2, which is not only of the dimensions of a length but also gives the order of magnitude of the radius of the electron in interaction with a proton, a length which is fundamental in recent electrodynamics. That the radius of the atom is of a different order of magnitude no more implies of itself a new constant of Nature than the size of the living cell.

Jeans repeatedly (pp. 139, 193, etc.) speaks of "ordinary physical" space and time as something quite familiar and distinct from the conceptual spaces of the mathematician; in a fundamental analysis we choose some particular conceptual space as convenient for particular physical phenomena. He speaks of "the special properties of *this particular world*" (p. 49) as though philosophically it were legitimate to speak of the totality of things as if these were but a part of a wider whole. On pp. 17 and 96 he describes the world as *unintelligible*, on pp. 82 and 174 he describes it as *rational*; whatever meanings I allow these two attributes, I find them contradictory. He is sweepingly condemnatory of older "aether" theories; but he blandly accepts the four-dimensional space-time "continuum" (a disguised aether) and speaks of Nature's "dodging action at a distance" by "making gravitation act on space" (p. 119), and though he admits that this only "postpones the difficulty" he does not take it up again. He never questions the conservation laws, although that of energy has led to the introduction of an unobservable particle—the doubtful neutrino; and although the conservation of linear momentum, applied to a set of discrete particles, is not without difficulties in the light of the theory of relativity.

Again, Jeans considers electric and magnetic forces as not real at all, but mere mental constructs. One may agree with this, but not for the reason given by Jeans, that they "do not even pass the test of objectivity" (p. 200); a vector or tensor is none the less 'real' because its components depend upon the axes chosen, and if we have to accept a four-dimensional continuum as real, why not a four-vector? He does not criticize the classical theory of relativity on its vulnerable ground, namely, that it ignores the uni-directionality of time for each observer. Lastly, he commits a philosophical error in the clause, "If we know nothing about a particle except that it exists" (p. 201), for we cannot *know* of the mere existence of a particle from our own perceptions; observation of the kind considered in physics could not merely indicate the quality 'existence'; it must make some numerical assertion about that existence.

In a lighter vein, Jeans says he is not clear about $2 + 2 = 4$. He seems to think that because two sea-serpents plus two sea-serpents might remain only two sea-serpents (perhaps by cannibalism?), therefore he is entitled to throw doubt on the proposition $2 + 2 = 4$ (p. 46). Surely this is a proposition not of physics but of pure mathematics, and such propositions, he admits (p. 49), are universal.

Jeans comes to no final verdict, but inclines to the view that phenomena do not form reality but are only an extrusion from a deeper-lying substratum, not in space-time. This, he thinks, may resolve the apparent conflict between causality and indeterminism. He might well here accept a spoonful of the medicine he hands out to philosophers: the answer to that conflict must surely be that it is falsely couched in terms of conflict, that we must not consider it as an antithesis of black and white but reconsider it in greyer shades, and that what mathematical philosophy might reasonably be asked for is a calculus which intervenes between classical causation and the nescience of probability theory.

E. A. MILNE.

NUMBERS, NUMBERS, NUMBERS

Guide to Tables in the Theory of Numbers

By Derrick Henry Lehmer. (Bulletin of the National Research Council, No. 105: Division of Physical Sciences, Committee on Mathematical Tables and Aids to Computation, Report 1: Report of the Sub-Committee on Section F, Theory of Numbers.) Pp. xiv+177. (Washington, D.C.: National Academy of Sciences, 1941.) 2.50 dollars.

THE U.S. National Research Council has embarked on the ambitious venture of producing a series of reports dealing with mathematical tables and aids to computation in every branch of mathematics, as well as in allied and associated subjects. All the reports are to take fully into account what is important in current research, and are to be written in such a way as to be intelligible for the most part to specialists in other fields. The reports are prepared primarily for scholars and others active in scientific work.

The present report, which is due to D. H. Lehmer, is the first of the series, and it sets a high standard indeed for the others. The book consists of three parts, of which the first is a descriptive survey, or rather some account of what the tables contain, often with a considerable amount of useful explanatory matter. This is written so as to be helpful to those most likely to consult the tables, including the amateur mathematicians who are more often attracted by number-theory than by other branches of mathematics.

The second part contains a bibliography giving the sources of the tables quoted in Part 1, and also some indication of the libraries in the United States and Canada where they are available. The third part contains a list of errata found in the tables, many by Lehmer himself.

Lehmer has produced an eminently readable and serviceable volume. He has brought to bear on his task more than a wide knowledge of number-theory and skill in calculation. Nothing appears to have been omitted that will conduce to ease in consulting the book, whether it is a question of arrangement, of explanation, or of reference. All arithmeticians are sure at some time or other to need this book and to have every reason to be grateful to him.

The volume suggests some reflections. In no other part of mathematics do tables of some kind play so important a part in research. This is not surprising since numbers are so fundamental in the mental development of man. Even in an early stage of civilization, the least curiosity or the slightest manifestation of intellectual activity led to the investigation of the properties of numbers. Then followed experiments with numbers and the gathering of numerical material. This led to empirical and inductive conjectures, some of which were proved in due course; and for many years practically every theorem in number theory was suggested in this way. There is ample evidence to this effect in the works of the great mathematicians Euler and Gauss, both of whom were renowned for their powers of calculation. Those conjectures, however, which were not soon proved, led to the further accumulation of numerical results used in testing the conjectures. Many results, the proofs of which now seem very simple, were very difficult to prove at first, and hence the great variety of tables in number theory.

The reader may be curious as to what has constituted the life-blood, so to speak, of arithmeticians. A glance at Part 1 of this book is most instructive, and I note a little of what is immediately intelligible. Probably the most useful are factor tables. In the early part of this century, D. N. Lehmer, the father of the present author, constructed a factor table for the first ten millions (and a few more numbers) which was published in 1909. No error has as yet been found in the 2,372,598 entries of Lehmer's table. Among the most interesting factor tables are those associated with the Mersenne numbers and giving the factorization of many numbers of the form $2^p - 1$, where p is a prime less than or equal to 257.

Prime numbers have long occupied the attention of arithmeticians, and there are many tables of various kinds. Empirical evidence suggested to Legendre and Gauss that the number of primes less than a given large integer x was asymptotically equal to $x/(A \log x + B)$, where A and B are certain constants. This was proved with $A = 1$, $B = 0$ by Hadamard and De La Vallée Poussin independently in the early 1890's. D. N. Lehmer utilized his factor tables to publish in 1914 a list of prime numbers up to a little more than ten million.

The Pellian Equation $x^2 - Dy^2 = 1$ or -1, where x, y are to be integers, is an equation famous in the history of mathematics since the seventeenth century. The first sizable table was published by Legendre in 1798 and went as far as $D = 1003$. It was continued by Bickmore up to 1500 and published by Cayley. Finally Whitford published in 1912 solutions for $1500 < D \leqslant 1700$, and D. H. Lehmer has produced a manuscript containing the solutions for $1700 < D \leqslant 2000$.

Among the tables which proved particularly useful for theoretical investigations were those dealing with quadratic forms in two variables; for example, the tabulation of non-equivalent quadratic forms $ax^2 + 2bxy + cy^2$ with given determinant $d = b^2 - ac$. This was started by Legendre, but extensive tables were computed by Gauss, the founder of the modern theory, and published after his death.

The study of the important partition function $p(n)$ was also materially influenced by tables. $p(n)$ is the number of solutions in positive integers of the indeterminate equation $x + 2y + 3z + \ldots = n$, and was introduced into analysis by Euler, who tabulated it up to $n = 59$ some time about 1750. This table was not extended until 1917, when the researches of Hardy and Ramanujan led to MacMahon's calculation of $p(n)$ for $n \leqslant 200$, and this was exceedingly important in the interpretation of new results for $p(n)$.

Goldbach's conjecture that every even number greater than 2 is the sum of two primes was propounded nearly two centuries ago. No proof of this has been found, though its truth is supported by many tables.

Finally, we may refer to tables dealing with

Waring's problem and in particular with cubes; for example, the conjecture, proved only recently by Dickson, that every positive integer is the sum of at most nine positive integral cubes. It is thought that only four cubes are required for sufficiently large numbers, but this has not been proved. Many tables give the least number of positive cubes required to represent a number n. Thus in 1835, Zornow gave tables for $n \leqslant 3000$. These were recomputed and extended by Dase to $n \leqslant 12{,}000$ and published by Jacobi in 1851. These were extended by Sterneck to $n = 40{,}000$ and published in 1903. Finally, an unpublished manuscript of Dickson continues the table to $n = 270{,}000$. Other tables of cubes have been computed by Western. Despite all these tables, it is not yet known whether every integer can be expressed as a sum of four cubes of integers of any sign (though the question is very simple with five). I venture to suggest, however, that tables will play a prominent part in answering the question.

L. J. MORDELL.

BRITISH ARCHÆOLOGISTS IN GREECE

The Annual of the British School at Athens

No. 38: Session 1937–38. Pp. xii+154+35 plates.
No. 39: Session 1938–39. Pp. viii+112+30 plates.
(London: Macmillan and Co., Ltd., 1940, 1942.) 42*s.* net each.

THESE handsome volumes render account of the archæological work of the British School at Athens in the two seasons preceding the outbreak of war, and illustrate its range and high standards of scholarship. They differ in contents, the earlier presenting a part only of the results of a single series of excavations; the later, seven shorter papers, of which only one is an excavation report, and the others are studies of inscriptions, museum collections, and the like.

The exploration of the upland plain of Lasithi in east-central Crete was undertaken by the late J. D. S. Pendlebury, with the assistance in 1937 of Miss Money Coutts and Miss Pascoe. In this secluded region the best-known site, the cave sanctuary of Psychro, was visited by Sir Arthur Evans in 1895, and explored by the British School in 1901–2. As its contents ranged in date from early bronze age to archaic Greek times, it was evident that the settlements in the plain below it had likewise a long history, spanning the cultural gulf between Minoan and Hellenic culture, and offering exceptional opportunity for examining the many problems, archæological and historical, of the transition. To this Pendlebury had already devoted several seasons, and the results here described are the reward of a type of intensive regional exploration which will supersede the older raids on isolated and fortuitous objectives, wherever local conditions are favourable, and mature students can be found to devote more than a single season to a 'dig'. To provide the means for such intensive study and prolonged acquaintance is one of the major preoccupations of the British School and similar institutions everywhere. The days of the 'wandering scholar' are not over, by any means—wide and planned travel remains a first pre-requisite—but reconnaissance is only the prelude to excavation as an instrument of scientific advance.

Main results of the work in Lasithi are the discovery of other cave sanctuaries, like Psychro; the examination of a mainly bronze age settlement, Kastellos Tsermiádhon, occupied from Neolithic to Middle Minoan times, when it seems to have been deserted except as a cemetery; and the revelation at Karphi, a strong natural fortress on the edge of the plain, of a 'city of refuge' established when the old Minoan regime collapsed at the beginning of the iron age, and maintained throughout the 'intermediate period', which seems to have ended about 900 B.C. Then, the open country being safer, the inhabitants of Karphi descended once more from the 'peg' to which they had clung for two centuries. Truly Aristotle was not far wrong when he described the Greek city-state as "coming into being to keep men alive", a *pis aller* to which Cretans have recourse again to-day. Here is a real piece of historical spadework, of which the intricate detail must be sought in this well-written record, fitting memorial of its brave and brilliant author, who was wounded in Crete in 1940, and thereafter murdered by Germans.

Two of the papers in volume 39 are of exceptional interest. Miss Benton's excavation of the cave-sanctuary on Polis bay in Ithaca is part of a concerted exploration promoted and largely maintained by the late Lord Rennell of Rodd, whose judgment as scholar and yachtsman was that the topographical descriptions in the "Odyssey" deserved archæological verification. In previous seasons Mr. W. A. Heurtley, then assistant director of the British School, detected the remains of a bronze age fort and habitation at Pelikáta, commanding all landing places in the northern half of the island, thus confirming the place-name 'City Bay' (Polis) for a cove practically uninhabited in classical or medieval times. On the steep side of Polis bay Miss Benton explored a cave-sanctuary the vogue of which began in the bronze age, and was continuous until late Greek times; and one of its votive offerings was inscribed in Greek "a prayer for Odysseus". In earlier Hellenic times a great dedication of bronze tripod-cauldrons attested the fame of the little shrine, whither gifts came from so far afield as Ionian and Italian cities.

Here, then, was the continuous vehicle of tradition from the days of the bronze age post above the bay to those of the poet of the "Odyssey". The argument is simple and conclusive: only Teutonic perversity could have argued that because Ithaca is now called Ithaca, Homeric Ithaca "must have been" somewhere else: *Sagenverscheibung* most pedantic. But the work was not easy. The cliff had subsided since ancient times, and Miss Benton had to grope for her tripods, knee-deep in a tideless sea.

During Schliemann's excavation at Mycenæ in 1877, a group of gold objects was found, outside the stone-built 'Circle', which commemorated the famous 'shaft-graves', but obviously belonging to the same culture as their splendid equipment. When the British School made supplementary excavations around the 'Circle', it became clear (as Schliemann himself supposed) that these objects came from another 'shaft-grave' which had been broken up when the 'circle' was constructed, or by a drain built soon after. Miss Helen Thomas now shows, by minute study of the gold-work and the site, that these treasures stand rather late in the 'shaft-grave' series, that they were looted from a grave of that period, but that what was found in 1877 had been hurriedly re-buried in the grave itself when the rest of the treasure was removed.

Among the other contributions, a report on the various charcoals found in Miss Winifred Lamb's excavation of an early bronze age settlement at Therm in Lesbos illustrates the great variety of calls on experts in other sciences, which are unavoidable in archæological work; and also the return which excavation can make, in evidence for the history of vegetation. Miss Bancroft, of the Imperial Forestry Institute at Oxford, identifies no less than seven varieties, including both vine and olive (not demonstrably cultivated) and a climbing plant like Salacia which does not seem to grow now in Lesbos.

JOHN L. MYRES.

SEASONAL RHYTHMS IN MAN

Seasonal Influence on Growth, Function and Inheritance

By A. B. Fitt. (New Zealand Council for Educational Research, Educational Research Series, No. 17.) Pp. xiii+182. (Christchurch, Auckland and Wellington: Whitcombe and Tombs, Ltd.; London: Oxford University Press, 1941.) 10*s.* 6*d.* net.

THE physiological cycles of lower mammals in relation to the seasons of the year must have been included in the earliest biological knowledge acquired by primitive man when he first began to observe the processes of Nature. On the other hand, corresponding functional rhythms in man are too inconspicuous to have attracted attention without deliberate inquiry. Even so, it has for a long time been recognized that the rate of growth of the human body is to some extent influenced by, or correlated with, the seasons. Data bearing on this question, partly the result of personal observations, have recently been collected and analysed by Prof. A. B. Fitt, and published by the New Zealand Council for Educational Research. These data include the weight and height increases of school-children, the weight increases in tubercular patients, seasonal fluctuations in muscular capacity, mental ability, mortality, suicide and delinquency, and the relation of weight, height, intelligence, etc., to the month of conception. The last subject is unfortunately included by the author under the general heading of "Seasonal Influence on Inheritance", a phrase which is clearly misleading, for the relevant data do not include a correlated study of the corresponding characters in the parents.

Prof. Fitt finds that the weight increase in children is at a high level in the autumn-winter half of the year and continues at a fairly low level in the spring-summer half. On the other hand, the height increase maximum coincides with the weight increase minimum. There is a phase of high vitality in the autumn, followed by a phase of low vitality in the spring. Rates of crime and delinquency are relatively low in the autumn and winter and high in the spring and summer, while the rates for suicide and insanity are similar to those for crime except that, instead of diminishing at the end of spring, they increase up to midsummer.

In considering the possible explanations of these periodicities, the author concludes that they reflect fluctuations in the 'stress' to which the growing individual is exposed at different seasons of the year. However, he does not define clearly the meaning of his concept of 'stress', and the reader gets the impression that this is little more than a convenient term for expressing the general results of the investigation. As to the cause of the periodical variations in 'stress', the author is strongly inclined to the view that they have an endogenous origin, that is to say, they are the expressions of an internal rhythm, possibly related to fluctuations in endocrine activity, rather than the result of environmental factors of temperature, light, humidity, diet, and so forth. Here many readers will find that Prof. Fitt proceeds much too fast for their liking. The discussion on hibernation in mammals and its relation to endocrine functions will possibly appear too indirectly related to the main thesis of the book, and the author seems too lightly to dismiss the influence of environmental factors as of little significance. We would suggest, in this connexion, that reference might appropriately have been made to the extensive studies on the effect of light on pituitary activity and thereby on general behaviour, particularly in birds and lower mammals. We note, also, that no reference is made to the detailed studies which have been made on seasonal differences in the growth of separate tissues such as the hair and nails. But perhaps it is a little ungrateful to point out such omissions, for undoubtedly Prof. Fitt's book is a valuable compendium of data of great importance to the sociologist and educationist.

The author concludes by briefly discussing some important implications which arise from his work, particularly in relation to the adjustment of the educational year to the seasonal rhythm of bodily functions. Even if it should be argued that the further analysis of more extensive data will be required before they can be confidently applied to educational policy, it will be agreed that Prof. Fitt has clearly pointed out the need for future research along these lines.

W. E. LE GROS CLARK.

LAPLACE TRANSFORMS

The Laplace Transform

By David Vernon Widder. (Princeton Mathematical Series.) Pp. x+406. (Princeton: Princeton University Press; London: Oxford University Press, 1941.) 36*s.* net.

THE theory of Fourier integrals arises out of the elegant pair of reciprocal formulæ

$$f(x) = \frac{1}{\sqrt{(2\pi)}}\int_{-\infty}^{\infty} F(y)e^{-ixy}\,dy,$$

$$F(y) = \frac{1}{\sqrt{(2\pi)}}\int_{-\infty}^{\infty} f(x)e^{ixy}\,dx,$$

in which either of the functions $f(x)$ or $F(y)$ may be arbitrarily given, and the other is then determined by it, and also forms the kernel of an integral formula which represents the given function. The Laplace formula is

$$f(s) = \int_{0}^{\infty} e^{-st}\,\phi\,(t)\,dt,$$

or the limits may be $(-\infty, \infty)$, with a corresponding reciprocal formula. The two theories are really the same, since one set of formulæ can be reduced to the other merely by a change of the variable.

When I commenced analysis some twenty years ago, the theory of Fourier transforms was little more than a footnote to the more popular theory of Fourier series. There were the classical applications to the solution of partial differential equations, such as those given in the book of Riemann-Weber. But what is now considered as the fundamental theorem of the subject, that if $f(x)$ has its squared modulus integrable over $(-\infty, \infty)$, then so has $F(y)$, had only just been proved by Plancherel. Little use had been made of the theory in its up-to-date form, and no books on the subject existed.

To-day the position of Fourier integrals might be compared with that of power series in the old theory of functions. A Fourier integral is the natural way in which one represents functions of certain classes, and the various generalizations of the integral, such as the Stieltjes integral, enable us to bring wide classes of functions within the scope of the method.

The subject of the present book is the same as that of a book by G. Doetsch in the Grundlehren der mathematischen Wissenschaften series, but the details are widely different. This work begins with a very useful detailed account of the theory of Stieltjes integrals, and the Laplace integral is mainly considered in the Stieltjes form

$$f(s) = \int_0^\infty e^{-st}\, d\alpha\,(t).$$

The theory of the representation of a function of a complex variable s in such a form is established. Applications are then made to moment problems, to the theory of absolutely and completely monotonic functions, to Wiener's general Tauberian theorems and the prime-number theorem. After a discussion of the bilateral Laplace transform (with limits $-\infty, \infty$) applications are made to the 'Stieltjes transformation'

$$f(x) = \int_0^\infty \frac{\psi(t)}{x+t}\, dt$$

and related topics. Much of the analysis is the author's own original work. This very lucid presentation of it will be welcomed by all students of the subject.

E. C. TITCHMARSH.

THE NEW BIOLOGY

Molecular Films, the Cyclotron and the New Biology

Essays by Hugh Stott Taylor, Ernest O. Lawrence and Irving Langmuir. (Rutgers University Publications of the One Hundred and Seventy-fifth Anniversary Celebration, No. 4.) Pp. v+95+24 plates. (New Brunswick, N.J.: Rutgers University Press, 1942.) 1.25 dollars.

THERE are many ways of celebrating an academic anniversary, though some, alas! are not available in war-time. The method adopted by Rutgers University to honour its one hundred and seventy-fifth anniversary has been to commission and publish a series of essays by men of distinction in science and learning.

One is always glad to hear from Dr. Irving Langmuir on any topic he chooses to handle; in this instance it is molecular films. He has a way of making profound things seem obvious which is very flattering to the intelligence of the reader. The remarkable results which are still flowing from the Berkeley cyclotron keep one on the *qui vive* for any new account by its inventor and director, Prof. Ernest Lawrence. There is no doubt that a collection of essays gains much if there is some more vital connexion between them than the mere fact that they happen to be enclosed in the same covers. The theme of the present volume is the interrelation of the physical and biological sciences in the past, and the hopefulness for mankind of still closer co-operation between them in the future. The theme is stated explicitly by Prof. H. S. Taylor in his introductory essay on "Fundamental Science from Phlogiston to Cyclotron". "To go forward to meet the years of difficulty ahead," he writes, "we shall need the effort of all men of good-will among whom the scientist, by the nature of his calling, must certainly be numbered. The processes of mutual co-operation and assistance among the individual sciences must be multiplied. The isolation of one science from another must become progressively less and less even though the degree of specialization within a science becomes perhaps greater and greater. This calls for an increasing breadth of culture and of education among the scientists." Prof. Taylor's excellent survey of the history of science during the past 175 years is in the nature of a commentary on this theme. The essays by Dr. Langmuir and Prof. Lawrence provide, in fuller detail, forcible illustrations of the argument from science actually in the making.

In his essay on "Molecular Films in Chemistry and Biology" Dr. Langmuir deals mainly with the chemical aspect, contenting himself with pointing out that the method is one which must throw very considerable light, when properly applied, on many of the obscurer problems of biology. He is offering a tool which the biologists have still to make use of. The cyclotron has already captured the imagination of the biologists, particularly of the medical biologists, and Prof. Lawrence has much progress to report on subjects as diverse as the treatment of cancer, the action of enzymes and vitamins, the secrets of photosynthesis, and the digestion of proteins.

The book is not addressed specifically to the general reader—it assumes some acquaintance, at any rate, with scientific nomenclature—but it should not be difficult reading for anyone who takes an intelligent interest in the progress of the sciences. Biologists, both medical and lay, to whom it is particularly directed, should find it both fascinating and stimulating; though whether they will consider the subtitle of the volume, "The New Biology", to be, as yet, quite justified remains to be seen. That the new weapons now being forged will bring, as Prof. Lawrence predicts, "exciting new pioneer days of discovery" in biology as well as in physics and chemistry is already certain.

This brief review has, I fear, done rather scant justice to Prof. H. S. Taylor's admirable opening essay. By way of *amende*, I quote its concluding sentences. "The modern world, says Maritaine, by which I mean that world which is coming to an end before our eyes, has not been a world of harmony between forms of wisdom, but one of conflict between wisdom and the sciences, and, he adds, it has seen the victory of science over wisdom. Have not we scientists, so to speak, to surrender that victory? We shall not yield our energy, our courage, our diligence in the search of truth. We shall but renounce the primacy to which a sick world has thrust us; and we shall gain by our renunciation. In the free world to which we still dare to look forward, with the soldiers and statesmen, artists, philosophers and priests we shall integrate our scientific skills with the social and spiritual aspects of human life and nature. Let this, we may pray, be an horizon not too far distant."

J. A. CROWTHER.

POLYGENIC BALANCE IN THE CANALIZATION OF DEVELOPMENT

By DR. K. MATHER

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ONE of the greatest differences between genetics to-day and genetics of thirty years ago is to be found in the changed attitude of geneticists towards the relation of a gene to the character, or characters, which it affects. The early geneticists equated a given gene difference to the character difference from which its existence was inferred. The gene for tallness in peas gave tall peas and its allelomorph gave short peas. The significance of the fact that a tall pea, as Mendel himself observed, could be 6 ft. tall or 7 ft. tall or of intermediate height was overlooked; the variation in height of tall peas was not discontinuous and so was not obviously attributable to a gene or genes detectable by the Mendelian technique. Such an attitude is very understandable because the success of Mendelian analysis lay in its concentration on simple character differences, in its exclusion of all extraneous variation from account. But this outlook carried with it disadvantages too, for concentration on discontinuous variation in experiment led easily to the assumption that the variation by which evolutionary changes were effected was just as sharply and obviously discontinuous. The outcome was the mutation theory of evolution on one hand and the presence and absence theory on the other.

It is true, of course, that after, say, 1906 all geneticists were familiar with the fact that the expression of one gene could be contingent on the presence of a given allelomorph of another gene. Bateson[1] gives an extensive account of the inheritance of complementary and epistatic genes, but the observations could be interpreted so easily in terms of the presence and absence theory that they did little or nothing to shake the idea of what we may perhaps call the characteristic expression of the gene.

Soon, however, several lines of approach led geneticists to doubt the validity of this simple interpretation and finally to abandon it altogether. Four deserve special mention. Bridges[2] found that the inheritance of sex in *Drosophila melanogaster* could not be explained in terms of the presence or absence of any given gene or genes. The numerical relations, or, as he called it, the balance, of the chromosomes, present in all flies, determined whether they would be supermale, male, intersex, female or superfemale. A little later Fisher[3] pointed out that the genes controlling mimetic patterns in insects must be presumed to have been given their special properties by the selection of other genes. He later concluded that even the dominance relations of one gene must be dependent on other genes of the nucleus, and the existence of such dominance modifiers has since been amply verified by experiment. Muller[4] showed that the expression of sex-linked genes must be supposed to be subject to genetical adjustment, for otherwise no reasonable explanation could be given of the equality or near equality of expression of these genes in the two sexes. There exists a means of dosage compensation. Finally, Timoféeff-Ressovsky[5] was able to demonstrate, by direct experiment, that the expression of certain genes in Drosophila was modified by the action of other genes. The dependence in expression of any given gene on the other genes of the nucleus, on the genetical background as it is often called, is thus beyond doubt.

This change of ideas concerning the relation between gene and expression has had a profound effect on the attitude of geneticists towards evolutionary change, as recent writings have shown. Ford[6], Muller[7] and Huxley[8] have especially developed the application of this new outlook to the better understanding of adaptation and evolution. It is not without significance that the rise of the idea of the dependent action of genes has progressed side by side with a return to Darwinism and the abandonment of the mutation theory.

Some further consequences of this view have now been discussed by Waddington[9]. In particular, he points out that the dependence in expression of one gene on the action of others permits a more co-ordinated response of the organism to its environment. Using both embryological and genetical data he shows that development may be regarded as canalized, that is, that although an organism may follow any one of a number of developmental paths, it is difficult to make it develop along lines intermediate between these possibilities. In genetical language, the integrated genotype acts as a buffering system, in such a way as to limit the variation of the organism's response to environmental fluctuations. Major or switch genes may determine which of the paths will be followed, but systems of other genes, the buffering action of which can be adapted by natural selection, will delimit the possible paths with greater or less precision. The switching action may have originally depended on environmental differences but, as Waddington points out, this function can, and generally will, be transferred ultimately to a genetic difference, and in this way will come to operate with greater efficiency and regularity.

Now, although the distinction between switch genes and buffer genes must not, for reasons which we shall presently discuss, be pressed too far, it is clear that the parts they play in controlling development are quite different. We may then expect them to be detected in different ways, to have effects of different magnitudes and to respond differently to selection. Genetical evidence is now available on these points and with its help we can form a clearer picture of how such co-ordinated systems arise and of how they change under the action of natural selection.

The familiar genes of genetical experiment fall into the category of what we have called switch genes. They are not usually known by this name, being more often called major mutants or qualitative genes, to distinguish them from the minor genes controlling quantitative characters. These two classes have also been called[10] oligogenes and polygenes respectively from the oligogenic and polygenic nature of the variation which they determine. With some important exceptions, which we shall discuss in a moment, the variant types to which switch, major or oligogenes, call them what we will, give rise, are not to be found in wild populations except as rare, and presumably recent, mutations; for unless some important end can be achieved only by diversity of allelomorphs of such genes, one allelomorph will have an unconditional selective advantage over the rest and will, apart from the slight effect of mutation pressure already noted, oust its competitors. Thus although we can only rarely detect the operation of such a gene by the genetical method of observing the different expressions of at least two allelomorphs, we must assume their action in wild organisms.

As but one allelomorph of any such gene is common in the wild, only those buffer genes which control the expression of this allelomorph will be subject to the action of natural selection. The systems buffering the action of the rare, or mutant, allelomorphs will not be so well adapted through selective action to the better fulfilment of their task. Hence when a mutation occurs in the laboratory, or a rare mutant type is found in and introduced from wild material, we should expect its phenotype to be more variable than the wild type, the buffering system of which is constantly adjusted by natural selection. This expectation is in full accord with the observed properties of mutant types, many of which have highly variable phenotypes. It should be noted that this argument presupposes that the various allelomorphs of a gene guide development into channels the directions of which are determined by unlike buffer genes. This has, in fact, now been verified by Haskell[11] in the case of the gene scute in *Drosophila melanogaster*.

The organization of the system of genes buffering the development of wild type individuals is of paramount importance to the organism. It must primarily determine the production of a relatively uniform type under conditions which may be subject to considerable fluctuations, as indeed is implied by ts description as a buffering system. Certain complications may be observed, as, for example, adaptation to show ecological plasticity, but these only serve to emphasize our main point, since they imply buffering in such a way as to produce two or more relatively uniform types according to the action of an environmental switch. But to be successful the system must have some elasticity, even though it is only potential, for the inability to respond to trend changes in the environment would mean that sooner or later the species would die out, no matter how well ts buffering system were adapted to coping with non-persistent environmental fluctuations.

The way in which uniformity is combined with potential elasticity has been revealed by Mather's[10,12] analysis of polygenic variability. The buffering ystem is built up of polygenes having effects which are similar to one another and individually small as ompared with environmentally determined fluctuaions. Natural selection builds up linked combinaions of these genes, in which the constituent members of the combinations balance each other in action. Inter-combinational uniformity of immediate action is combined with the ability to produce new combinations of different action by means of recombinaion between the various existing combinations. Thus the buffering action depends on polygenic balance, which can and does change as a result of ecombination, so permitting the emergence of new ombinations which are capable of re-aligning the developmental path to give fresh adaptation to hanged circumstances. The polygenic variability is hidden, or potential, in the genotype and is not free n the phenotype. In other words, we can see how, as Waddington puts it, the system has absorbed its own variability. Inasmuch as the maintenance of adequate polygenic balance depends on the regular action of natural selection[10], it is easy to see that the polygenic ystem buffering the expression of mutant switch genes will be inefficient, for it will not have been elected for inter- and intra-combinational balance.

This concept of polygenic balance, and the storage of variability in its potential form, enables us to approach a number of evolutionary questions. There is, for example, the problem of polymorphism, whether of the kind known in grouse locusts or mimetic butterflies, or the more familiar type, sex, heterostyly, etc., on which the breeding structure of a population depends. These are the exceptional cases mentioned earlier, in which the success of the species depends on diversity of a switch gene. It is of no use having females, for example, if no males are available.

The direct determination of sex depends on the action of the sex chromosome inequality, which is the switch gene in this case. But how is the organism adapted to produce functional females and functional males with but rare exceptional individuals, and how was this sharp difference in type of individual first produced ? Though we have stated the question in terms of sexual dimorphism, this is only a particular example of polymorphism, and the answer to this question will apply to polymorphic species in general.

Clearly this answer must be sought in the ability of the polygenic system to distinguish and delimit adequately the paths into which development can be turned by the operation of the switch gene. The latter may itself be composite and so capable of some modification[13], but, in the main, close adaptation must be polygenically determined. Only a polygenic system is capable of giving all grades of expression between wide limits. The balance achieved by the polygenic combinations will determine the end products, and if this balance is adequate the end products of the developmental paths will be functional male or functional female according to the line into which development was guided by the switch gene. Each type can, and will, be adjusted by the action of selection on the buffering system of polygenes ; and in so far as the types are capable of such adjustment, dimorphism will arise and develop continuously, under the action of selection, from the store of potential variability which lay hidden in the polygenic combinations of the undifferentiated ancestral form. The action of the switch gene, giving so obvious and sharp a discontinuity, is made possible by the continuous adjustment of polygenic balance.

Two predictions follow from this argument. In the first place, it should be possible to change the polygenic balance of a polymorphic system by operating on it with unbalanced combinations from a related system which is not adapted to show polymorphism. The polymorphism need not be lost in such a case : the switch gene will merely determine a less efficient polymorphism after the operation. This has been shown to happen to the incompatibility system in Petunia[14]. In *Petunia violacea* gametic incompatibility, which is a type of polymorphism affecting the breeding system, is determined by a series of *S* allelomorphs of the kind well known in Nicotiana species. The related *P. axillaris* shows no incompatibility. It was possible to isolate, from the F_2 of a cross between these species, plants identical in constitution with the *P. violacea* parent in regard to switch gene (that is, the *S* gene), but which were less strongly self-incompatible than was that parent. Furthermore, the two plants, *P. violacea* and the second generation species hybrid, were reasonably freely inter-compatible, though two plants of like *S* constitution within *P. violacea* would have been quite inter-incompatible. The polygenes from *P. axillaris*, not balanced to give incompatibility, have recombined with the balanced combinations of

P. violacea to give new combinations determining a new incompatibility system, which, however, depends on the same switch gene. As we should expect, this new system is not so precise in action as the old one, for these new combinations have not been fully balanced by the operation of natural selection.

Turning to the second prediction, we can see on the polygenic view that two related species, or populations, may show the same end result, yet reach it by balancing different polygenes of similar effect. Indeed, if the groups are isolated, this will be inevitable, because a polygenic system is in a constant state of flux. Its balance is stable but the constituent polygenes producing this balance are changing by mutation, fixation and so on. Now in such a case the joint balance of any pair of combinations can only be maintained by the continual operation of natural selection, and if two combinations are never present in the same nucleus, that is, are isolated, they will have a poor joint or relational balance, though they may have the same internal balance, and though each may be capable of working harmoniously with other combinations from which it is not isolated. Isolation means divergence of polygenic organization (but not of necessity of intra-group polygenic balance as expressed in the phenotype), because it prevents inter-group balance being maintained by natural selection.

It is to such inevitable cryptic divergence that we must attribute hybrid sterility in species crosses, though, of course, bars to crossing must have a selective origin. In particular, however, we should expect that two related species showing the same polymorphism, operated by the same switch gene, would depend on different sets of balanced polygenes to give this common result. On inter-crossing, therefore, the character in question should lose its sharp definition in later generations after the two sets of polygenes had recombined and so lost balance. This is found to be the case with incompatibility in Nicotiana. *N. Forgetiana* and *N. alata* show pseudo-compatibility only in exceptional circumstances, that is, the actions of the various allelomorphs of the switch gene are always distinctive; but in *N. Sanderæ*, a horticultural type derived by hybridization of the two foregoing species, pseudo-compatibility is rife, though the operative switch locus, *S*, is the same as that of both parental species[15]. Pseudo-compatibility marks the breakdown of the distinction between the types produced by the *S* allelomorphs. We can see that it is not the switch mechanism, but the buffering system of polygenes, to which the breakdown must be attributed, exactly as expected.

Thus the character or reaction, the expression of which is apparently dependent on the switch gene, is in fact conditioned by the buffering polygenes. If the latter are not adequately balanced the operation of the switch gene is partially or even wholly vitiated. The buffering system can also change in such a way that it endows the switch gene with an apparently new set of properties. The path or paths into which the latter directs development are so remoulded and redirected that the outcome is quite a new type.

Such changes can be recognized as having taken place in the evolution of flower colour differences in the genus Petunia[14]. *P. violacea* has magenta coloured, and *P. axillaris* white, flowers. The latter is homozygous for the allelomorph *w*, giving lack of anthocyanin in this species, of a gene the other allelomorph of which, *W*, homozygous in *P. violacea*, results in the presence of anthocyanin. When, however, the species are inter-crossed the F_2 contains coloured plants of the constitution *ww*, and what is more, these plants may have a flower colour indistinguishable, at least by inspection, from that of other plants which prove to be *Ww* when tested. The effects of the gene *W,w* are conditioned by the genetical background of the species. The background of *P. axillaris* is so adjusted that *w* switches flower development into a track leading regularly to white pigmentation. The buffering system of *P. violacea*, which does not carry *w*, is naturally not so adjusted and, in an F_2, affects the path of development so that *ww* expresses itself in a new way, namely, by giving coloured flowers. Thus the discontinuity in effect of *W* and *w* is a reflection of the buffering system. The switch gene has been given its characteristic properties by the adjustment of the genetical background or buffering genes. Clearly the evolution of such a specific difference can proceed gradually by continuous steps, even though the eventual discontinuity between the species is controlled by a few major genes.

This leads us to the problem of the relation of switch genes, major genes, oligogenes or whatever we choose to call them, which have large effects, to polygenes, the effects of which are so small as to be individually unrecognizable. It does not seem reasonable to suppose that the nucleus contains two kinds of genes, having sharply distinct properties (though it must be pointed out that there exist two kinds of chromatin, eu- and hetero-chromatin, the latter of which appears in general to be devoid of major genes but to contain polygenes). We have, however, seen that the apparently large phenotypic effect of a major gene is, at least in part, a property of the polygenes which determine the ultimate result of the major gene's action. In fact we may surmise that the difference in phenotypic expression between the allelomorphs of some major genes could be reduced to nothing by the reverse of that process of polygenic adjustment which has endowed them with the property of conditioning sharp phenotypic discontinuity.

But it would be straining both evidence and reason to suppose that a major gene was originally, in al cases, merely one of a number of like polygenes, any one of which might by chance have had the switching role thrust upon it by adjustment in balance of the rest. Rather it would seem that the switch gene operates at an earlier ontogenetic stage, the later acting genes then having the power of reducing or magnifying the difference in outcome of the path into which this major gene directs development and inasmuch as the latter genes do operate later their own effects are small and, at least in part interchangeable. We may note, too, that in such a case the organism could, without undue loss in fitness, afford to carry a greater store of variability for the later acting polygenes than for major genes for their individual disruptive action will not only be smaller, but will also be conditioned by the othe polygenes present.

This leads us to the speculation that major, switch or oligogenes were at one time polygenes. Th distinction between the two classes is one of time o action, and hence of magnitude of average effect, th apparent discontinuity of type being due to th buffering or enhancing action which the polygene exert on the effects of the earlier acting major genes In other respects the two kinds of gene are alike, fo both mutate, segregate and show linkage. It then follows that a gene which is now a polygene acting at a late stage in the development of an organ may, either alone or as part of a complex of linked polygenes, assume the role of a switch gene if and when the developmental history of that organ is extended by its morphological and functional elaboration. A gene which has a minor effect on the corolla structure of a relatively unspecialized flower could have a drastic effect on the corolla of a flower elaborated and specialized in the way observed, for example, in an orchid.

This is, perhaps, an unduly simplified discussion of the problem, and the questions raised, for example, by neoteny require consideration at a length not now possible. But the principle that genes have evolved in function can scarcely be denied. Indeed the evolution of an organism is an expression of the functional evolution of its genes.

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STUDIES OF WILD POPULATIONS

By DR. C. B. WILLIAMS

AT a joint meeting of the Royal Entomological Society and the Genetical Society held on December 3, there was a general discussion on methods of study of wild populations.

Prof. R. A. Fisher, president of the Genetical Society, opened the proceedings with an account of recent developments in the method of estimating the numbers of a wild population by liberating a known number of marked individuals and later recapturing a random sample. Thus if a hundred marked flies are liberated and, after a short interval to allow of their mixing with the wild population, a number of flies are captured at random and found to include 1 per cent of marked individuals, then it can be assumed that the original wild population was approximately ninety-nine times the number of marked flies or 9,900 individuals.

If a series of such observations are made at short intervals, say on successive days or every week, it is possible to extend the mathematical analysis to supply estimates, on one hand of the death and emigration rates, and on the other hand the birth or immigration rates. If several contiguous areas are sampled the effect of birth and death can be separated from the effects of movement.

Since the total number of individuals captured and the total released on different days may vary, it is of value to convert all to a 'recapture frequency' which is the number of marked recaptures to be expected if both the numbers released and the total number recaptured were a hundred.

The method has been used particularly with tsetse flies by Jackson in East Africa and on certain butterflies and moths in England particularly by Ford, and there are interesting differences between the former case, in which the insects are flying over long periods with relatively small changes of number, and the latter, in which the brood rises to a peak and falls away again within a few weeks.

The idea of random sampling, which is the central and typical statistical operation, aims at supplying estimates of the population numbers, and birth-rate and death-rate, together with a knowledge of the precision of these estimates which is seldom available by other methods.

Dr. C. B. Williams dealt with some methods of finding the changes in insect population used at Rothamsted Experimental Station in recent years. Direct sampling had been used by Dr. H. F. Barnes to trace the changes in numbers of wheat midges over a period of fourteen years, and the number of slugs caught in thirty minutes at night had been found to be a fairly accurate method for estimating changes in a slug population. Direct sample counts had been used by K. D. Baweja to demonstrate the return of the insect population to an area of soil previously rendered sterile by heat.

The method of sampling by means of a light trap provided an interesting mathematical problem, as the catch in the trap is directly affected by changes both in activity and in population numbers. By considering the difference between catches at short intervals (for example, successive days) the activity factor became dominant, while by comparing monthly average captures in successive years the population effect was emphasized. It was then found possible to correct average catches for the effect of environment on activity and to have left a more exact measure of the population change. Later it was found possible to forecast these changes from a knowledge of the weather conditions during the previous months.

Dr. Williams also dealt very briefly with a new method, recently developed by Prof. R. A. Fisher and himself, for studying the relative abundance of different species in a mixed wild population. By means of a logarithmic series it is possible, if one knows the number of individuals and the number of species in a random sample of a mixed population, to calculate three sets of information. First the relative frequency of rarer and commoner species, as for example the number of species represented in the sample by one, two, three or more individuals; secondly, the number of species which would have been obtained in samples containing fewer or more individuals from the same population; and thirdly, a numerical measure of the extent to which the population is divided up among species, which has provisionally been called the 'index of diversity'. As the error of this 'index' can also be calculated it is possible to say if two random samples are taken from populations of similar composition or not. The calculated results fit very closely indeed to the observed numbers.

Mr. George Salt pointed out that there are two principal aspects to the study of animal populations. One can ask the question "How many ?" and answer it by making a census ; or one can ask "How do there come to be so many, neither more nor fewer ?" The curve of population growth, stated by Malthus on theoretical grounds to be exponential, was found by Pearl, Gauss and others in a variety of experiments to begin as though exponential, but then to change over to a sigmoid form. Three groups of factors have been suggested as effecting the change: competition for food, conditioning of the medium, and density of population. Owing to its applicability to human populations, the last of these has monopolized the interest of most observers; the second has been the subject of much work by Park; the first, competition for food, has been comparatively neglected. Experiments with blowflies show that, as increasing numbers of maggots compete for a fixed amount of meat, the average weight of the surviving larvæ gradually falls, there is an increasing loss of life in the larval stage, and eventually the number of survivors falls off rapidly. These laboratory experiments have their parallel in wild populations, and Holdaway has shown that, from an initial population of 63,200 Lucilia larvæ competing for carrion in Nature, only thirty reached the adult stage. A similar illustration of the law of diminishing returns has been demonstrated in a parasitic insect. In the case of these animals, and probably of others, it is in the larval stage, the principal feeding period, that the size of the population is largely determined by the available food supply.

Owing to the absence of Dr. Julian Huxley, who was to have taken part in the discussion, a communication was read from Dr. Ll. Lloyd on the effect of environment and competition for food on the insect fauna of sewage beds.

The population studied was made up of relatively few species, including three Chironomids, two Psychodids and one Enchytraeid worm, and it was possible in this simple community to see the effects of both intra- and inter-specific competition for food.

The vigorous Chironomid, *Metriocnemus longitarsus*, and the worm *Lumbricillus lineatus* dominate the situation and live in the topmost zone in the beds where the eggs of most species are laid. Cool wet summers are favourable to these dominant competitors, while hot dry summers are adverse to them. A cool June is followed by an abundance of *M. longitarsus* and a consequent reduction of the other Chironomids, *M. hirticollis* and *Spaniotoma minima*. The latter, however, specially counters the Psychodids deeper in the beds, so that these have a more prolonged abundance after a cool June.

M. longitarsus and *Psychoda severina* have the capacity of active winter breeding and one would expect that mild winters would be favourable to them. But the worm intervenes, and in a mild winter pulverizes the surface growth and sooner or later destroys it. Thus conditions are made more unsuitable for the two insects and they tend to become scarcer rather than more abundant in mild winters.

A. N. Barker, in a parallel study of the Protozoa of the beds, found a close negative correlation between the abundance of these organisms in summer and that of the grazing larvæ as assessed by fly trapping.

Dr. U. Phillip said that we can obtain information about the finer structure of free-living populations by studying both genetical and cytological variability. Genetical variability may be investigated by inbreeding insects from the field. It will then be found that every individual is heterozygous for at least one factor, if not for many more. From the occurrence of such factors the structure of the free-living population may be deduced. For the study of structural hybridity the larvæ of the Chironomidæ are very favourable material on account of their large salivary gland chromosomes. By investigating the frequency of various sequences of factors in the chromosomes (inversions) which occur together, it was found that larvæ living together in such a small closed locality as a rainwater butt came from a random mating population of unknown size.

We have so far had only indications of the type of breeding groups that may be found, because our methods of collecting and evaluating our results statistically are not sufficiently refined.

Prof. J. B. S. Haldane discussed the importance of genetic polymorphism in a wild population. He classified polymorphism as (1) manifest, for example as seen in mimetic associations; (2) cytological, in which the animals appear similar but have differences in chromosomes; (3) cryptic, as where recessive characters are normally hidden, but may be discovered to be present by inbreeding.

In the first two cases the population tends to come to an equilibrium in the proportion of the different forms, but not in the latter.

He pointed out that recoveries of individual Drosophila had been made in wild populations at some distance from the laboratories, which showed genes in certain combinations which had first been made in the laboratories. This indicated their origin by escapes.

An analysis of polymorphism throws light on the breeding system of a population, since a small inbred group soon becomes homozygous or nearly so. The study thus enables us to estimate the rough order of magnitude of an interbreeding population.

Mr. E. B. Ford directed attention to the relation between the size of a population and its variability as seen by him in a locality where the butterfly *Melitœa aurinia* occurred over a long series of years. At first the butterfly was rare and rather uniform in appearance. Then followed a period of rapid increase in numbers accompanied by a great increase in variability. Finally the population settled down to more or less stability of numbers at a level much higher than originally, and simultaneously it became much less variable, but not in the same form that had been dominant at the beginning of the observations.

Dr. E. A. Cockayne discussed briefly the problem of melanism and its occurrence in industrial areas. He considered that the melanic forms which became dominant in certain 'industrial areas' occurred as rarities over the rest of the range of the species. He also had evidence that there were frequently very considerable differences in the proportion of melanic forms in some species of moths in localities relatively close to one another, quite independent of any possible effect of the proximity of manufacturing towns.

Dr. W. Ripper expressed the hope that the method of correcting a sample for activity so as to leave a more definite population-number effect, as described by Dr. Williams for his light trap studies, could be extended to other sampling problems, particularly those of immediate agricultural importance.

Mr. Classey remarked that the varying proportion of the sexes in different species caught in a light trap might reduce the value of this as an estimate of populations.

Dr. P. A. Buxton, president of the Royal Entomological Society, in summing up the discussion, emphasized the great scientific and economic importance of the study of populations and said that nearly every problem in economic entomology is a problem of numbers. He suggested that it would be most valuable if someone could produce a critical review of the various methods now in use for obtaining estimates of the number of individuals in wild populations.

LUMINESCENCE AND COLOUR

A FEW years ago luminescence was little more than a curiosity of slight academic importance; to-day it forms the basis of new and important ndustries. The Colour Group of the Physical Society devoted its tenth science meeting, held on December 11, to its consideration, when four papers were read and discussed.

In the opening paper, on "The Chemical and Physical Properties of Luminescent Materials", Dr. J. W. Strange reviewed the development of luminescence and referred to the alchemical, if not culinary, flavour which still pervades the preparation of phosphors. He declared, furthermore, that the lack of rigid chemical control and co-operation between chemist and physicist has accounted for a good deal of the lack of progress in understanding luminescent phenomena. The words alchemical and culinary might, with some justice, be applied to the early attempts at making luminescent powders, but can scarcely be applied to the preparation of modern highly efficient phosphors, where chemical control is rigid in the extreme. So-called pure chemicals as purchased are rarely good enough for manufacturing luminescent powders, and these are generally subjected to careful purification before use.

It is true that theory lags far behind the practice of luminescence, and there does not appear to be much common ground as yet where the theoretical chemist or physicist and the luminescent powder chemist can meet. Nevertheless, as pointed out in the discussion following the meeting, acknowledgment must be made for the contribution of X-ray analysis to the development and understanding of crystalline phosphors. The way in which X-ray spectroscopy has contributed to the elucidation of luminescent problems has recently been described by Rooksby (*Electrical Times*, 102, 260; 1942).

Dr. Strange described the preparation of crystalline phosphors by firing the precipitated compound or the component oxides with the appropriate activating metal and flux at temperatures between 850° and 1,200° C. Manganese is the most important activator, but copper, silver, bismuth and a few others are also used, there being an optimum concentration for each phosphor.

Phosphors such as calcium and magnesium tungstates and zinc sulphide, which do not require an activator in the accepted sense, appear, at first sight, to conflict with the theory of active centres, which is largely based on the discovery that traces of certain heavy metals in a suitable crystalline matrix produce luminescence. The modern tendency, however, is to regard these apparent exceptions as conforming to the general rule. Thus there is evidence that in pure luminescent zinc sulphide there is a stoichiometric excess of zinc in the lattice which behaves as the activator. The main function of the flux, which is generally a halide, is to speed up the reaction or to bring it about at a lower temperature. Except possibly in certain sulphide phosphors, which require the presence of a halide for maximum efficiency, the flux does not appear to enter into the composition of the luminescent material.

Dr. Strange referred to some of the uses of luminescence in analytical work, atomic physics, electric discharge tubes and cathode ray tubes. In cathode ray tubes the relation between light output and tube current is of particular interest in connexion with theories of the mechanism of luminescence. It is a remarkable fact that the phosphor still continues to show an increase in light output with increase in current even at a power loading as high as 12 watts per sq. cm. of screen.

He concluded his remarks with a brief review of the modern interpretation of luminescence based on the idea that the atoms of the activator form the active centres for absorption and emission of radiation.

Mr. H. G. Jenkins read the second paper of the series, on "Commercially Useful Fluorescent Substances", which he dealt with under the headings: inorganic phosphors, fluorescent glass and fluorescent organic substances. A number of demonstrations were given to illustrate the luminescent characteristics of the various types of substances discussed.

The relation between the luminescent characteristics of the sulphide phosphors and the composition of the matrix, the activating metal and the furnacing treatment were briefly discussed. The most interesting property of the sulphides from the present point of view is their ability to fluoresce strongly when they are excited by near ultra-violet or even visible radiation.

Referring to the very beautiful colour effects obtained with these materials under filtered long-wave ultra-violet radiation, Mr. Jenkins mentioned that luminescent sulphide paints were being used very effectively before the War in conjunction with black-glass lamps for fluorescent posters and displays of great beauty and artistic merit. The black-glass lamp comprises a quartz high-pressure mercury vapour discharge tube rated at 80 or 125 w. in an outer bulb of nickel glass. The transmission of the nickel glass at 3650 A. is about 70 per cent and only a negligible amount of visible radiation is emitted by the lamp, which is one of the most convenient and efficient sources of near ultra-violet radiation available.

With normal paints and pigments, additive mixtures give subtractive mixtures of light. Thus a yellow pigment is yellow because it absorbs blue, and, as everyone knows, a mixture of blue and yellow paints gives green. In mixing fluorescent pigments, however, the artist has to deal with an additive mixture of *lights*, and he finds that blue and yellow no longer give green, but white. It is, of course, necessary for the artist to mix his luminescent pigments and to use them under ultra-violet radiation, with visible light excluded so far as possible. With comparatively little practice the new technique is easily acquired.

Some curious effects are observed with luminescent colours under conditions of scotopic vision; thus yellow luminescent inscriptions are more easily read than are blue, even when the brightness of the yellow is somewhat lower. This is probably due to the use of parafoveal vision for the shorter wave-lengths and consequent inability to focus. The high sensitivity of the periphery of the retina to blue and bluish-green colours makes it possible to see, although not to focus, these luminescent colours at brightness levels too low for normal vision to function. It can in certain circumstances produce a feeling of discomfort in the dark-adapted eye analogous to glare at normal illuminations.

Mr. Jenkins next described phosphors excited by ultra-violet radiation of wave-lengths shorter than 3000A., of which zinc silicate, zinc beryllium silicate and magnesium tungstate are perhaps the best known, and pointed out that these are commercially much more important than the sulphide types because of the efficiency with which they are excited by the low-pressure mercury vapour discharge. More than 50 per cent of the total input energy in the low-pressure mercury discharge is emitted as resonance radiation of wave-length 2537 A. and below. It is possible to convert a considerable fraction of this energy into visible light by means of fluorescence, resulting not only in sources of high luminous efficiency, but also, what is scarcely less important, in sources in which the spectral luminosity can be controlled.

As might be expected, luminescence in glass is even more complex and difficult to understand than that in crystalline materials. The luminescence centre may be an ionized molecule such as $UO_2{}^{++}$, or a covalent molecule such as cadmium sulphide, or neutral atoms such as silver, lead and tin; or the luminescence may be due to a crystalline material such as zinc silicate precipitated in the glassy surround. In the latter case the glass is opalescent due to the presence of undissolved crystalline material. Mr. Jenkins referred to the various types and showed a number of examples. Apart from its use for discharge tubes, the fluorescence of glass activated by rare earth atoms has been used to study the structure of glass and to supplement the information given by X-ray analysis.

Fluorescence has been used by glass manufacturers as a convenient method of identifying their product. Small amounts of cerium give a blue fluorescence and do not affect the colour or physical properties of the glass. Cerium has also been used as an indicator to study the movements of molten glass during manufacture.

Luminescent enamelled surfaces are usually prepared by binding certain sulphide phosphors in a boro-silicate type of enamel frit. By mixing suitable phosphors with certain synthetic moulding resins, luminescent plastics for use as switch covers, name-plates, etc., are prepared.

Referring to organic fluorescent materials, Mr. Jenkins mentioned that commercial anthracene is a characteristic example. This substance fluoresces green in the solid state and blue in solution in benzene, and the green bands reappear if the benzene solution is frozen in liquid air. Very pure anthracene fluoresces blue in both the solid and solution states. It thus appears probable that the green fluorescence is caused by an impurity, stated to be naphthacene, in the crystalline anthracene matrix, and that the blue fluorescence is a property of the anthracene molecule itself.

Many organic compounds are fluorescent only in liquid or solid solution states, or when adsorbed at high dispersion on fibres or on inorganic adsorbents. The fluorescent dyestuffs such as fluorescein, eosin, rhodamine and auramine are well-known examples. Unlike the fluorescent dyestuffs, organic materials such as anthracene, quinine, etc., which fluoresce in the solid state, possess little or no body colour. Some of these colourless substances have all the characteristics of fluorescent dyes and can be incorporated in fabrics like any ordinary dye to give a colourless dyeing which is highly fluorescent. Dyes of this type have found an interesting application for marking linen in laundries, the sorting being done under black-glass lamps.

For spectacular lighting and display effects, fluorescent dyes are often used in conjunction with resins as lacquers and applied by brushing or spraying. When the lacquer is dry, the dye molecules are dispersed in a thin film of resin which serves to isolate them energetically.

Two interesting engineering applications of organic fluorescent substances were mentioned. The first is in connexion with the surfacing of tools, gauges, etc., where the prussian blue used in the normal method is replaced by anthracene. The high spots appear as brightly fluorescing regions. The second application is to the detection of fine cracks in metals—particularly non-ferrous metals where the colloidal iron and powerful magnetic field method cannot be used. The metal part is treated with a strongly fluorescent substance, and after removal of this from the surface the cracks show up as fine bright lines under the black-glass lamp.

A paper on "Fluorescent Lamps: Their Photometric and Colour Rendering Properties and Measurement" was read by Mr. G. T. Winch. High-voltage fluorescent tubes, high-pressure mercury vapou fluorescent lamps and the newest types, the mains voltage fluorescent tubular lamps, were briefly reviewed. Mr. Winch described the accepted metho of visual photometry when colour differences are involved: the field of view is kept down to about 2° usually with a suitable filter in front of the sub-standard tungsten lamp to minimize the colou difference. The transmission factor for the filter is determined from its spectral transmission and the luminosity distribution of the sub-standard lamp Even when a colour match is achieved, it may b necessary to use a group of observers, owing to th large differences in luminosity distribution whic generally exist.

Discussing physical photometric methods, Mr Winch described his ingenious 'physical eye' photo meter, where the light from the source after dispersa in a spectroscope passes through an aperture o special contour before falling on the photo-electri cell. By adjusting the contour of the mask, th apparatus is made to have 'average eye' spectra response without any knowledge of the spectra sensitivity of the photocell.

The difference between the colour of a source an its colour rendering was strikingly demonstrated b showing the wide difference in colour rendering o fabrics which could result when placed under light of the same colour but of different spectral luminosit distribution. To assess the colour rendering propertie of a source, it is necessary to know something abou its luminosity distribution. It has been shown tha for most purposes it is sufficient to measure th relative luminosity in about eight suitably chose adjacent spectral bands. Much had already bee accomplished in this connexion, but although th method showed considerable promise, the War ha interrupted development work, and a good dea remains to be done before it can be applied t commercial fluorescent lamps.

Referring to the variability of natural daylig Mr. Winch pointed out that the colour temperature the light from the sun varies over the enormous rang of 2,000°–25,000° K. according to conditions. It for this reason that industrial establishments co cerned with colour rendering prefer, for their colou matching work, to use an artificial daylight sour corresponding to one of the phases of dayligh usually that of a black-body radiator at a temperatu of about 7,000° K. The luminous efficiency of thes artificial daylight sources is too low to make mo than localized lighting with them possible, and it was not until the introduction of high-voltage fluorescent tubes that general lighting at high illuminations with a light of daylight quality became an economic possibility. The more convenient mains voltage fluorescent tube which was introduced later has made this form of lighting much more generally available.

Mr. Winch described how, by a process of repeated interchanges of lamps and measurements between the leading lamp manufacturers, and elaborate colour-rendering tests with many observers, the luminosity distribution of the present 5 ft., 80 w. fluorescent lamp was evolved. The colour of the tube is fairly close to that of illuminant *C* specified by the C.I.E. (6,500° K.), and the colour rendering is adequate for nearly all purposes except those concerned with the most critical discrimination of colour. The daylight colour of these lamps has proved of considerable psychological importance in war-time factories and other situations where natural daylight is largely or completely excluded and where work is carried on for twenty-four hours of the day.

Mr. F. W. Coppin read an interesting paper on "The Use of Fluorescent Pigments in Colour Printing". Owing to the impossibility of ensuring that the printing inks used in photomechanical colour reproduction processes have the theoretically correct hue, compensating corrections have to be made at some stage in the process. For relief printing these correctives take the form of local adjustments to the dot size in the plates, or 'fine etching' as it is called, and for photolithography, hand re-touching of the screen. These operations are highly skilled and somewhat uncertain, and many attempts have been made to introduce the corrections by mechanical methods.

In the fluorescence process blue and green fluorescing materials are included in certain of the paints, and the colour separation negatives are made by mixing with the normal copying light some additional near ultra-violet radiation. The special paints comprise a set of eighteen water colours which are used by the artist under normal lighting conditions. Slight modifications in the normal technique are necessary to produce different hues by mixing colours, in order to avoid upsetting the fluorescence balance.

Arc illumination is used for making the colour separation negatives. For the yellow and magenta printing negatives, the arcs are shielded by special hoods fitted with filters which allow only ultra-violet, blue violet and green light to reach the copy. The correct ratio of ultra-violet to visible light is obtained by adjustable slits and compensating filters, using control patches on the copy-board. The blue-green printing negative is made using a panchromatic plate with the direct light of the arc on the copy and a Wratten No. 29 filter over the lens. For the black printing negative an infra-red sensitive plate is used and an infra-red filter over the lens.

Mr. Copping showed examples of colour charts prepared with the special paints and reproduced by the method described. For completely faithful reproduction, the hues of the four colour-printing inks should correspond to those for which the fluorescent paints have been balanced, but almost any good set of four colour inks will yield results which are sufficiently accurate for commercial purposes.

OBITUARIES

Prof. Franz Boas

PROF. FRANZ BOAS, who died on December 21 last, was born at Minden, Westphalia, in 1858, and did most of his scientific work in North America, becoming instructor in anthropology at Clark University in 1882 after university studies at Heidelberg, Bonn and Kiel. He worked in physical anthropology, linguistics, evolution of material cultures and social characteristics and ceremonial, besides writing suggestive essays on questions of wide interest and making a notable attack upon the racist theories of Nazidom. Though he thus clearly belonged to what in Britain is sometimes called the Huxley-Haddon tradition of general practice in anthropology, he yet showed, as did Huxley and Haddon, a capacity for detailed observation as well as wide generalization. Among the outstanding features of his scientific work were his studies of the Eskimo in Baffin Land (1883–4) and his plan for and conduct of the Jessup North Pacific Expedition (1897 onwards) to study the relationships of peoples of North America and Northern Asia. As professor of anthropology in Columbia University (1899 onwards), as well as for a time curator of ethnology at the American Museum of Natural History (1901–5), Boas found opportunities to co-ordinate the researches of different workers, and he became a central figure in the field of North American, and especially Eskimo, ethnology.

Boas's observations were much valued even if at times his theories were set aside; in such a field, theory is inevitably in a high degree provisional. He emphasized cultural similarities—the kayak, umiak, harpoon, household utensils, rituals and hero-tales, pictographic art and realistic carvings—between the Eskimo on one hand and the Chukchee and Koryak of north-east Asia on the other. But he rejected the view that the Eskimo peoples and their cultures had originated in Asia and spread to America. The findings of his Jessup expedition led him to think of the Eskimo of Alaska as comparatively new arrivals there from farther east in America. Indeed, he thought that several Palæ-Asiatic peoples of Siberia should be considered to have been immigrants from America. Needless to say, he shared the general view that the original peopling of America was due to movements from Asia; all he added to this was the idea of a backwash. Subsequent work has revealed evidence of older cultures in Alaska; and it is increasingly realized that diffusions of culture and movements of peoples in arctic America and the region around the Bering Sea have been complex, and probably by no means all in one direction; but ancient drifts from Asia to America are universally thought to have been fundamentally important. An Asiatic cradle for Eskimo culture is nevertheless not generally accepted, and Stefansson, for example, has the view that from the forests north of Lake Superior the ancestors of the Eskimo drifted northwards to the Barren lands and thence went on both eastwards to Greenland and westwards to Alaska. It seems established that the arctic Eskimo culture, which has an obvious unity throughout, came into the Arctic two thousand or more years ago, and was once more prosperous than it has been in recent centuries.

Boas believed that the peoples of the extreme south and south-east of South America and those of the north-west of North America must be considered fringing groups imperfectly imbued with the culture which had developed, in the main, on the American continent, though the roots might be Asiatic; he thus emphasized here again the importance, in his view, of cultural evolution in America. He believed that there were cases of similarities between peoples, due not to borrowing but to psychological factors working parallel to one another. He would, however, have nothing to do with necessarian theories. Totemism, for example, seemed to him to be a term covering a wide range of associated ideas and customs; but neither are the widespread similarities proof of a unitary origin, nor is totemism a necessary expression of thought of a particular stage in human evolution. After suggesting that the Northern Kwakiutl of the Northern Pacific were in a stage of transition from mother-kin to father-kin, he later went over to the opinion that from a father-kin system they were influenced towards a mother-kin scheme and division into totemic clans by borrowing from more northerly neighbours. Sir James Frazer held that the facts agree better with Boas's earlier view.

Deeply aware of the interdependence of all aspects of human life and work, Boas felt that as a teacher he could not easily neglect any. We thus have his comments and contributions in several fields. He thought of primitive art as arising from technical execution and also from the stylized expression of emotions and thought. Stylization seemed to him to give a measure in this field of work, provided it is understood in its broader sense of controlled form. He disagreed with the theory that geometric ornament develops through degeneration of perspective, or symbolic designs because of slurring and inaccuracy; and he emphasized the borrowings of forms and the changes in their interpretation as they pass from one people to another, or from one generation to another. Among one and the same people there may be two or more distinct styles, especially if these are associated with different industries carried on by distinct sections of the group. The desire for artistic expression, in his view, is universal.

In the field of physical anthropology Boas concerned himself to show the rapid mutability of head form, and he published elaborate statistics concerning descendants, of even the first generation, of immigrants from Europe to the United States of America. Some anthropometric workers accepted his conclusions, but some found difficulties in his analysis of the measurements he gathered; and it may be said that mutability of a rapid type is by no means a general feature, if it ever occurs, which is doubtful.

Boas's broad knowledge of material culture, linguistics, social organization, religious ideas and physical characteristics of human groups gave strength and cogency to his fiercely valuable attack on Nazi racism, and on all attempts to trim and distort scientific truth to suit dogmatic schemes in politics or in any other field of expression. He is one of those who have enriched the knowledge and understanding of mankind in more ways than can be specified by giving a list of special discoveries or theories or publications.

H. J. FLEURE.

WE regret to announce the following deaths:

Dr. George Washington Carver, director of the Research and Experimental Station and consulting chemist at Tuskegee Institute, Alabama, the distinguished Negro botanist, aged eighty.

Prof. R. G. Collingwood, F.B.A., late Waynflete professor of metaphysical philosophy in the University of Oxford, on January 9, aged fifty-three.

Dr. C. Tate Regan, F.R.S., lately director of the British Museum (Natural History), on January 13, aged sixty-four.

Dr. Nikola Tesla, the well-known electrical engineer and pioneer of radio telegraphy, on January 7, aged eighty-five.

Prof. Arthur Willey, F.R.S., emeritus professor of zoology in McGill University, on December 26, aged seventy-six.

NEWS and VIEWS

An American Steam-Boat Pioneer

ON January 21 occurs the tercentenary of the birth of John Fitch, the American pioneer of the steam-boat, who while other inventors were struggling with costly and inconclusive experiments built several working steam-boats, formed the first steam-boat company in the world and for a period carried passengers on the Delaware according to a time-table. Fitch was born at East Windsor, Conn., and after working on his father's farm, pursued various callings, including those of a brassfounder and a silversmith. He suffered many misfortunes, made an unhappy marriage, and during the War of Independence was taken prisoner. In 1780 he became a surveyor in Kentucky and later on took to map-making. On a journey in 1785 he conceived the idea of propelling vehicles and boats by mechanical means. Quickly visualizing the value of his ideas, he made models and drawings, secured favourable opinions from public men and during the years 1786–90 made three or four boats which ran with varying success on the River Delaware. In 1791 a French patent was secured and two years later Fitch visited France to further the exploitation of his invention in Europe. The Terror, however, was then at its height and he soon returned home, having exhausted his means. From that time onwards he strove unsuccessfully against an unkind fate, and died at Bardstown, Kentucky, in 1798, at the age of fifty-three. His merits have not gone unnoticed in the United States, and in 1926 Congress erected a memorial to him where he died.

Pamphlets in War-time

As in the War of 1914–18, so in this one, pamphlets are much in evidence. There is a saying of John Selden, who flourished in the seventeenth century, that "more solid things do not show the complexion of the times so well as ballads and libels". By "libels", however, Selden meant what we mean by pamphlets, for, as Archbishop Trench remarked, the extent of meaning which a word covers is often gradually narrowed. Any little book (*libellus*) was a "libel" once; now, only such as is scurrilous or injurious. The truth of Selden's saying is seen in the fact that pamphlets were plentifully produced until far into the nineteenth century, when popular magazines tended to replace them. Now they become plentiful again at times of great public excitement. The Oxford pamphlets of 1914–18 are still fresh in the memories of people who have reached or passed middle age. Pamphlets are with us again. They cover many subjects—scientific, geographical, historical, biographical, and all that relates to the Fighting Forces. For the most part they are authoritatively written, and "show the complexion of the times" very effectively.

Recent additions to the Oxford pamphlets (Oxford University Press, 3*d.* net) include Lieut.-Col. Casson's "Greece", written by one who is both a scholar and a soldier, and describing the character and traditions of the Greek people. Sir John Pratt, writing from an intimate knowledge of the Far East, describes in "Great Britain and China" the chief episodes in our relations with China since 1715, when the East-India Company set up its factory in Canton; and Admiral Sir Herbert Richmond, distinguished alike as naval officer and writer, in his "War at Sea To-day" makes clear to the layman the new difficulties of naval warfare, and the means adopted to meet them.

The latest addition to Federal Tracts, published by Macmillan and Co., Ltd. (6*d.* net), for Federal Union Research Institute, is Prof. George Catlin's valuable pamphlet on "Anglo-American Union as a Nucleus of World Federation"—a title which explains itself. The author's distinguished record as a student of politics, and as an exponent of this particular subject, marks him out as a high authority. World federation is for him the ultimate aim, but Anglo-American Union is the first step. Cultural autonomy is the due of all nations, even the smallest, but national sovereignty is not. Lord Balfour's reference to "an English-speaking method of looking at the great affairs of mankind" is recalled and enforced—that sense of a common culture which needs to be made more articulate. Prof. Catlin regretfully points out that the whole issue has received far less attention and publicity in Britain than in the United States and the Dominions.

"The Body as a Guide to Politics", by Dr. W. B. Cannon, formerly professor of physiology at Harvard, afterwards of the British Military Service, and later of the U.S.A. Medical Corps, is more directly scientific in tone. His general thesis, which may sound fanciful at first hearing, is that the external and internal relations and activities of the body are so marvellously organized by Nature that they may throw light on the present defects of organization by man. When danger threatens the body, stabilizing agencies act on the instant to guarantee security, but when danger threatens a nation disruptive factors have full sway. The pamphlet is an elaboration of the epilogue to Dr. Cannon's popular work "The Wisdom of the Body", published in 1932. It is included in the series "The Thinker's Forum", published by the Rationalist Press Association. In the same series appears Muriel Jaeger's "Wars of Ideas", expounding the claim that Nazi-ism is a new religion, with Hitler as its Messiah.

Geographical Names

THE vexed problem of geographical place names is raised again in an article in the *Geographical Journal* for October in which the Permanent Committee on Geographical Names of the Royal Geographical Society, Kensington Gore, S.W.7, enumerates certain principles which are offered for criticism. The whole memorandum is too long for extensive quotation but some of the main principles may be noted. Generally speaking, names should be those used by the responsible government or official survey of the country concerned, in the case of countries that use a Roman alphabet. In names of features or places in lands not using a Roman alphabet, transliteration, with certain qualifications, is recommended. But exceptions to these general rules are allowed. In popular, text and small-scale maps, English names of conventional usage are allowed; in learned works and large-scale maps conventional English names are allowed for marine features outside territorial limits and features of international interest, with the recommendation that the foreign official name, if it differs markedly from the English, should be given in brackets. Other exceptions are in favour of English or international postal names of important places that differ markedly from official names, and, in historical context, the use, either of the name or narrow transliteration of the name that prevailed at the time under consideration, or the name conventionally known to English scholars. It is emphasized that these principles do not necessarily represent the considered views of the committee but are put forward as a basis for discussion.

Russian Scientific and Technical Periodicals in Great Britain

ON the recommendation of the Anglo-Soviet Scientific Collaboration Committee, the British Council requested the Association of Special Libraries and Information Bureaux to undertake a survey of the war holdings of Russian scientific and technical periodicals available in Great Britain. The survey, covering the years 1939–42 inclusive, has just been completed, and summaries of the results may be obtained from A.S.L.I.B., 31 Museum Street, London, W.C.1 ("Wartime Guides to British Sources of Specialised Information, No. 4", 1*s.* 6*d.* to members of A.S.L.I.B., and 2*s.* 6*d.* to non-members, postage inclusive). More than two hundred specialized libraries participated in the survey, which covers three hundred and thirty-four periodicals. From the summarized results it is possible to tell at a glance whether complete series of each of the periodicals for the last four years may be consulted in the Science Library or Patent Office, whether complete series have been located in other libraries, or whether the series located are incomplete. For further detailed information concerning the location of incomplete sets and odd numbers of periodicals, application should be made to A.S.L.I.B., where an index showing the particular issues received, their location, and the conditions of their accessibility is maintained. It is apparent from the survey that very few of the 1942 issues have so far been located, but attention is directed to the considerable time-lag in transit.

Potato Tips as Seed

THE importance of the potato, not only as human and animal food but also as a raw material for the manufacture of starch, alcohol and synthetic rubber, has greatly increased in the U.S.S.R. since the War. At the beginning of the War a big increase in the potato crop was ordered by the Government, but to achieve the goal set, a large addition to the amount of seed potatoes available was necessary. Lyssenko claims that the problem can be, and to some extent already has been, solved by utilizing as seed small pieces of tuber weighing about half an ounce and containing one of the upper eyes. The rest of the tuber—about 90 per cent of the whole—can be used as food. It is said that tips yield as well as whole tubers and that their produce is less subject to disease. In 1942, in the U.S.S.R., 250,000 acres were sown with potato tips, and it is anticipated that ten times this area will be thus sown in 1943. This would mean an additional 8 or 9 million tons of potatoes in 1943 without having appreciably reduced the quantity available for food and industry in 1942.

Methods of Clearing Derelict Land

THE clearing and reclamation of derelict land has become an urgent problem on many farms in Britain to-day. In view of the recent developments in the mechanization of British agriculture, the new edition of Bulletin No. 101, "Hedge and Tree-Stump Clearing", by T. Swarbrick, recently published by the Ministry of Agriculture (price 6*d*.), should prove of great help to farmers faced with probably unfamiliar operations. The methods recommended fall into four groups: hand methods, the use of power, chemical agents and explosives. The means selected depends upon a variety of circumstances. Much can be done with timber jacks and monkey winches, especially when isolated trees are the chief problem. If hedges also need removing and no tractor is available, the use of a monkey winch in conjunction with explosives is suggested, for horses can then pull out the small stuff. As regards power methods, the track-laying type of tractor is undoubtedly most suitable for land clearing, but it is essential that full use be made of the dead weight of the tractor, its drawbar pull and the leverage exerted by making a high hitch on the tree and a low hitch on the tractor. Other forms of power such as steam tackle, gyro-tillers and bull-dozers can also do most valuable work, if the size of the job justifies the use of expensive equipment. Explosives, particularly gelignite, offer a simple means of removing tree stumps and hedges; full details are given in the bulletin as to how they should be employed. Farmers requiring further information or help are recommended to get in touch with the machinery sections of the county war agricultural committees, who are in possession of the necessary tractors and employ full-time machinery officers to organize the equipment.

School Science Teaching

THE recent issue of the *School Science Review* (No. 92, Nov. 1942) contains an interesting article, "School Science Teaching after the War", by Mr. E. T. Harris. Mr. Harris points out that science teaching before the War was greatly affected by economic and social conditions which, in some cases, created a hostile attitude. But now, due to its contribution to the war effort, science is valued and appreciated. The changed social conditions likely to prevail after the War should give impetus to the modern movement to stress the applications of science, but the principles should not be omitted. ". . . Science is a social phenomenon, and is only to be understood in relation to the human society in which it has developed and is developing. Its principles and its applications are closely interrelated aspects of the same social phenomenon, and they must be studied in conjunction." In discussing how this principle may be applied in teaching, Mr. Harris cites the introduction of general science and the greater attention which biology is receiving nowadays (see NATURE, 149, 456; April 25, 1942). There are two aspects to the study of science, (1) its historical and logical development and its social uses, and (2) its application to the pupil's life—his home, body, food, etc. Later in the science course should come a broadening of these early ideas, so that science is regarded as a struggle of mankind to master Nature for knowledge, power, and freedom.

A New Universal Bevel Protractor

MESSRS. E. R. WATTS & SON, LTD., 123 Camberwell Road, London, S.E.5, have designed and introduced a new type of bevel gauge which should prove a most valuable tool in the engineering workshop for the convenient and accurate measurement of angles. The instrument consists essentially of two straight-edges hinged together by means of the protractor head and capable of being set at any desired angle. The principal feature of this bevel gauge is the circular scale, which is divided accurately on a glass annulus mounted inside the head. The graduations on this scale are read by means of a high-power magnifier attached to the head and giving a wide field of view. The scale is most conveniently observed by looking through the eyepiece when the instrument is held in front of a source of artificial light, and under these conditions angles can be measured to within one twelfth of a degree. The straight-edges or blades are made of hardened steel and one of them is capable of sliding, an arrangement which greatly extends the range of the instrument, and two sizes of blade are provided—6 in. and 12 in. The sliding blade is secured by an eccentric operated by a lever extending from the centre. When fitted with the short sliding blade, the dimensions of the gauge, closed, are 6½ in. × 2⅜ in. × 1¾ in. and its accuracy in measurement is 5 minutes of angle. The blades are secured in angular position by means of a knurled ring concentric with and surrounding the protractor head so that, in all respects, this tool lends itself to rapid and convenient operation.

The Royal Observatory, Cape of Good Hope

THE 1941 report of H.M. Astronomer at the Cape, though showing only too clearly the impact of the War on South African astronomy, contains much of interest. The reversible transit circle has been fairly fully employed in making 7,234 transit observations, including fifty-seven of the moon, which were undertaken in view of the fact that lunar observations have perforce been dropped from the restricted programmes of many European observatories. With the Victoria telescope the stellar parallax programme has been continued, 2,642 plates having been secured during the year. A new determination of the parallax of Proxima Centauri, the star closest to the sun, gives 0·763″ ± 0·007″, in good agreement with the previously accepted figure of 0·762″ ± 0·005″; this should be compared with the value 0·756″ ± 0·007″ for α Centauri. It is interesting to note that during recent years the number of plates used for a parallax determination has increased to thirty, taken over three years or more: this change is fully in accord with the experience gained in the cloudier weather (but better seeing) at Greenwich.

The photoheliograph record of the sun's disc has suffered somewhat from the shortage of fine-grain plates, but a record, either on lantern plates or faster emulsions, was obtained on 311 days. Observations of occultations by the moon indicate a correction of 0·77″ to its ephemeris longitude, which is of course based on Brown's Tables. This correction is expected to reach zero in 1943. Cometary observations included the photographing of Comet 1941c (de Kock), which reached the second magnitude, and of Comet Cunningham, which did not live up to expectations and only just reached naked-eye brightness. The weather at the Cape over the year was cloudier than usual, rainfall being 40 per cent above normal, as the result of considerable falls on a large number of days rather than excessive falls on a few days. Substantial observing losses through cloud were recorded in the programmes of the Victoria telescope and of the photoheliograph, but in spite of the weather the increased efforts of a war-depleted staff actually raised the number of observations made with the transit circle.

A New Telephone Set for Partially Deaf Persons

AN article by A. Herckmans (*Bell Lab. Rec.*, 21, No. 2; October 1942) describes a new amplifying set which recently has been developed for use with the regular telephone set to assist the hard of hearing, and which permits all the added equipment except a small 4½-volt battery to be incorporated in the base of the telephone. The gain of the amplifier is adjusted by turning one of the switchhook plungers, and the amplifier can be disconnected by a second switch controlled by this same plunger. The switchhook plunger at the right of the set gives gain control and it may be turned to any one of three positions to give low, medium or high gain. Vertical motion of the plunger removes the amplifier from the circuit entirely. The very small amplifier unit consists of a granular-carbon microphone the diaphragm of which is actuated by a bipolar receiver element using permanent magnets. A soft rubber mounting prevents it from picking up vibrations from the surface on which the set is resting. When the amplifier is in use its receiver element is connected in place of the regular handset receiver, while its transmitter element is connected to the handset receiver in series with a 4½-volt battery which may be placed in any convenient location and connected to the set by two wires. With this arrangement the handset receiver is operated by the amplified speech from the transmitter element of the amplifier.

To prevent 'singing', the amount of gain around the closed path from the receiver to the transmitter through the air path and then back to the receiver through the induction coil must be less than the total loss. A maximum of 25 db. gain is provided by the amplifier used and 'singing' will not occur in normal use. A person is not conscious of impairment of hearing for ordinary room conversations until his loss is about 25 db., and only about 5 per cent of the population would be conscious of the need for a hearing aid. This percentage would be smaller for telephone conversations because the average speech level received is approximately 10 db. higher than that of normal direct conversation. With the additional 25 db. provided by the new set, persons with as much as 60 db. loss will receive adequate volume. Since only 0·5 per cent have a loss greater than this, the new set provides the help needed for about 90 per cent of those conscious of hearing impairment and would undoubtedly give considerable assistance to many with losses in excess of this.

Application of Electricity in Mine Pumping

G. B. Alvey and N. Tetlow, in a paper on this subject read before the Institution of Electrical Engineers on December 10, give a good deal of useful information upon electrically driven mine-drainage pumps, which may be of the centrifugal or of the positive displacement reciprocating type. Since the characteristics of the driven pump have a considerable bearing on the choice of the most suitable driving motor, the first portion of the paper deals with operating and design characteristics of the two types of pump. The remainder shows how, by a study of these operating characteristics, the most suitable type of driving motor may be chosen.

Control of Venereal Diseases in Peru

LAWS concerning the medical care of patients suffering from venereal diseases in Peru have recently been promulgated by the President (*J. Amer. Med. Assoc.*, October 17). A national department dealing with these diseases has recently been established with its headquarters in Lima. Treatment during the contagious stage is obligatory. If the patients are minors or mentally deficient, the parents are made responsible for their treatment. Drugs for the treatment of venereal disease are now sold only on medical prescriptions, and the sale of specific medicine by unauthorized persons and treatment by correspondence are prohibited. Wet nurses must have a certificate of health, which is given free of charge in the dispensaries and hospitals. Five per cent of all the beds in public hospitals are to be reserved for venereal diseases.

Edinburgh Geological Society: Clough Memorial Medal and Fund

THE Clough Memorial Medal for the years 1941–1942 has been presented to Mr. James L. Begg, of Mount Vernon, Glasgow, for his outstanding contributions to Scottish palæontology. He has worked for many years on the Ordovician rocks of Southern Scotland and has discovered more than a hundred new species of trilobites, mollusca, brachiopods, and other organisms, many of which belong to new genera. The majority of the specimens have been obtained from the classical sections of the Girvan region. Mr. Begg, who is a past president of the Geological Society of Glasgow, has also served as its honorary treasurer for the past twenty-five years.

The Clough Memorial Fund was instituted in 1935 for the purpose of encouraging geological research in Scotland and the north of England. The north of England is defined as comprising the counties of Northumberland, Cumberland, Durham, Westmorland, and Yorkshire. Under the terms of the administration of the fund a sum of approximately £30 is available annually. Applications for grants are invited for the period April 1, 1943–March 31, 1944. These should be sent to the Secretary, Clough Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh.

Greetings from Russian Physiologists

PROF. A. V. HILL, joint secretary of the Royal Society and foreign secretary of the Physiological Society, has received a cable of New Year greetings from the All-Union and Moscow Societies of Physiologists, Pharmacologists and Biochemists, expressing their confidence in complete victory during 1943 for the democratic countries. In his reply, Prof. Hill said he looked forward to joining with them in holding the Congress of Physiologists deferred from 1941 in Great Britain during 1944.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A World Language

Sir Richard Gregory, in his recent address to the Association of Special Libraries and Information Bureaux (ASLIB), reported in Nature of November 28, refers to the importance of developing a world language for international use after the War. He mentions the British Association Committee's investigations in 1919 which directed attention to the three alternatives:

(1) The use of a dead language, for example, Latin.

(2) The use of a national language, for example, English.

(3) The development of an artificial language such as Esperanto or Ido.

I venture to suggest that a fourth alternative should now be considered, namely, the use of a systematic sign language, as was proposed, nearly twenty years ago, by Prof. Daniel Jones, of University College, London.

I would exclude the instinctive pantomimic gesture language, as developed by all deaf mutes, for this language is *not* built up of separate signs equivalent to spoken words, and it is therefore almost as unfamiliar to all users of spoken language as spoken language is to the uneducated deaf. The natural pantomimic gesture language of deaf mutes represents in fact a different and altogether more primitive way of thinking from that used in normal speech.

The sign language for international use would be one (like the Red Indian sign language) in which every sign is the equivalent of a spoken word—so as to represent a unit of thought—but in which every sign is also pantomimically related to the meaning which it bears.

I have suggested elsewhere[1] that the spoken languages of primitive man were, in the main, derived from pre-existing sign languages of this type, the simple cause being that (as Darwin pointed out[2]) man's mouth and tongue tend to copy the movements of his hands.

From this it followed that *all* sign language was inevitably accompanied by gestures of articulation, while the equally natural urge of man to express emotional states by laryngeal sounds supplied the acoustic energy needed to convert gestures of articulation into audible speech sounds[3].

The advantages which may be claimed for a systematic sign language are:

(1) That every sign will appear natural to all nationalities alike.

(2) That—as experience has shown—the individual signs will be easily and quickly learnt and remembered.

(3) That the symbolism—being essentially pantomimic—will be more direct than that of any spoken or invented language.

(4) That the language will lend itself especially to use by children and the rising generation—as a form of play—and will give them at the same time a datum line from which to judge and compare the spoken languages.

(5) That the sign language will be at once simpler, more concise, and more unambiguous than any spoken language—owing to the much greater versatility and precision of the human hands as compared with the human organs of articulation (lips, tongue, etc.).

(6) That the sign language will be very easy to teach—on a world scale—by means of educational films and television, and that it will be free from all difficulties of pronunciation.

(7) That there is already available a vocabulary, of just under two thousand words, which any interested student of average intelligence might expect to acquire within a month. A longer period of practice would, of course, be necessary for gaining speed in signing and reading.

On the other hand, sign language has certain disadvantages, namely:

(1) It is at present unfamiliar—except to the born deaf.

(2) There is not, at present, any available script by which the hand gestures can be recorded and read—unless a cinema film of the person signing can be considered as a script of his signs.

Unfamiliarity of sign language is almost certainly not a serious objection—as witness the fact that all nationalities communicate by signs when the intending communicators cannot understand each other's spoken language.

The absence of a script, on the other hand, is a serious disadvantage, and the invention of an efficient script would be an essential factor in the development of sign language as an auxiliary international language.

Shortly before the present War broke out, that great master of script, Eric Gill, had begun to interest himself in the problem of devising a script for sign language. His premature death was a heavy blow not only to sculpture and the arts generally but also to sign language.

If any readers of Nature—or their friends—should be disposed to investigate the problem of recording the three-dimensional movements of sign language by means of a simple and artistic two-dimensional script, I would gladly give them any help in my power.

Miss Margaret Morris has devised a script for recording all the bodily movements in dancing[4]—the problem is much simpler in the case of sign language, where (in effect) only hand movements are concerned.

R. A. S. Paget.

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Shepton Mallet,
Somerset.
Dec. 16.

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[1] Nature, Feb. 23, 1929, p. 281; "Human Speech", Sir R. Paget, Kegan Paul, 1930, p. 133; Nature, May 14, 1938, p. 882.

[2] "The Expression of the Emotions", Chap. 7.

[3] "Human Speech", p. 37–39.

[4] "The Notation of Movement", Kegan Paul, 1928.

Control of Potato Blight (*Phytophthora infestans*) by Spraying with Suspensions of Metallic Copper

In 1807 Bénédict Prévost found that germination of the spores of the wheat bunt fungus (*Tilletia caries*) in water was inhibited by the presence of submerged pieces of clean metallic copper[1]. It has long been known that water contained in copper vessels becomes toxic to some species of algæ and bacteria. Since about 1885 many compounds of copper have been used in spraying plants for the control of fungus diseases, but in an extensive search of the literature[2], I have not found a single reference to the trial of finely divided metallic copper itself, for this purpose

Following the work of Horsfall, Martin, Marsh[3] and others, cuprous oxide has recently come into wide use as a general fungicide, but the mechanism of its action remains obscure. It is possible that in presence of some exudate 'E' from the fungus itself, one of the steps in the reaction may be:

$$2Cu_2O + E \rightarrow Cu_2 + 2CuE,$$

and it therefore becomes of much interest to examine the fungicidal effect, not only of the free cupric ion, but of the molecular copper that may be deposited.

The conduct of comparative trials of Bordeaux mixture, cuprous oxide, copper oxychloride and other copper compounds for the control of potato blight in Devon and Cornwall this year, gave me the opportunity of including plots sprayed with suspensions of finely divided metallic copper. Among the methods used in preparing these suspensions were: (*a*) reduction of copper sulphate with sodium hydrosulphite, (*b*) treatment of cuprous oxide with sulphuric acid, followed by repeated washing to remove the ionic copper, (*c*) precipitation of copper metal in dispersible form from copper sulphate solution with zinc dust, and (*d*) simple dispersion of fine electrolytic copper, or technical (B.D.H.) hydrogen-reduced copper metal. Methods (*a*) and (*b*) gave copper particles mostly of about 1 μ, and methods (*c*) and (*d*) mostly of 2–5 μ in diameter. Small-scale trials showed, as was to be expected[4], that suspensions of the smaller particles were the more effective, but for the main trials, on randomized plots, suspensions made by method (*d*) were chosen, to put metallic copper to the severer test, and to avoid the possibility of including traces of soluble copper compounds through incomplete washing out of the other materials.

Dispersal of the copper particles to obtain preparations in convenient practical form for application to the plants was secured by trituration of the reduced copper, in a dry or moist state, (*a*) with sulphite cellulose extract ('Sulphite lye'), or (*b*) with a mixture containing 97 parts of bentonite, 2 parts of aluminium sulphate, and 1 part of soda ash, by weight. Bentonite was used to ensure good adhesion to the foliage, as well as to stabilize the copper suspension. The small addition of aluminium sulphate and sodium carbonate in the above proportions was found to overcome the difficulty previously experienced when using bentonite with spray materials, due to its 'balling' into very slowly dispersible, sticky masses on addition to water. The method is an improvement on others I have used for this purpose[5], and its underlying principle is to prevent swelling of the bentonite when the preparation containing it is creamed with a *little* water, without causing flocculation of the fully diluted suspension. The same additions to the bentonite were made in preparing both the metallic-copper and the yellow cuprous-oxide suspensions referred to in the table below.

The chequer-board spraying trials were carried out on Arran Banner at Bude (1), and on Majestic at Dartington (2) and Kentisbeare (3). There were three replications of each treatment at each trial. All the spray fluids were made up to the same copper content, namely, 0·25 per cent copper by weight, and two applications were given, the first at the rate of 110 gallons per acre, the second at 140 gallons per acre, using a knapsack sprayer. Detailed assessments of the percentage of the foliage area affected by blight, on each individual plot, were made at frequent intervals. Full particulars of the trials will be published elsewhere, but, in short, at all three centres the blight attack, though late, was severe, and the metallic copper sprays, though not quite so effective as Bordeaux mixture, kept the plants green for three weeks after the unsprayed were dead, and throughout gave such good control of blight on the foliage as to indicate beyond doubt that metallic copper has very marked fungicidal activity, at any rate against *P. infestans*.

The effect on the yield of tubers was as follows:

	Mean total yield in tons per acre		
	Arran Banner (1)	Majestic (2)	Majestic (3)
Bordeaux mixture	14·4	14·3	16·1
Cuprous oxide plus bentonite	15·4	14·3	14·7
H-reduced copper plus bentonite	13·8	14·6	14·3
Control, unsprayed	10·6	11·1	11·6
Significant difference between treatment means (P=0·05)	1·4	1·7	1·8

The deposits on the leaves of the plants sprayed with finely divided copper appeared to retain the colour of the metal throughout the trials, but the possible occurrence of oxidation of the metal on exposure remains to be investigated. It also remains to be ascertained whether the fungicidal action of metallic copper, or of oxides resulting from the application of copper in metallic form, is specific to *P. infestans* or of wider application. If metallic copper sprays prove effective against the apple scab fungus (*Venturia inæqualis*), for example, they may be of great value on the copper-sensitive varieties, as there would appear to be less likelihood of scorch with metallic copper than with its more soluble or reactive compounds.

E. C. LARGE.

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Dec. 17.

[1] Prévost, B., "Mémoire" (Montauban, 1807).

[2] Large, E. C., "Advance of the Fungi" (Cape, 1940).

[3] Horsfall, J. G., Marsh, R. W., and Martin, H., *Ann. App. Biol.*, 24 867–82 (1937).

[4] Cunningham, G. H., "Plant Protection" (Palmerston North, 1935).

[5] Large, E. C., British Patent No. 493,148 (1938).

Loss of Thiamin from Cooked Potato

IN the course of assays of thiamin (vitamin B_1) in potato by the Phycomyces method[1], which involves cooking the potato samples in the process of sterilization, the method of sterilization was varied from time to time. One of these variations was of sufficient culinary interest to be briefly reported.

The normal method of conducting the Phycomyces test is to grow the fungus on small cylinders of potato in a liquid medium (pH 6·4); medium and potato are sterilized together by steaming for 45 minutes on three successive days. This process does not destroy the vitamin, for determinations by this method gave concordant results with those made at the same time on raw potato by the thiochrome method[2]. If, however, the medium is poured off from the potato after the three steamings, and replaced by fresh sterile medium, the loss in vitamin

LOSSES OF THIAMIN FROM MAJESTIC POTATOES.

Date	Thiamin in sample, sterilized normally (μ gm./100 gm.)	Thiamin (μ gm./100 gm.) remaining	
		After pouring off medium	After sterilizing at pH 9
Nov. 1941	103	34	26
Jan. 1942	179	11	21

is considerable. It is comparable with the loss incurred by sterilizing the potato at pH 9 instead of pH 6·4, as is shown in the table.

It would appear that the greater part of the vitamin is washed out into the medium in the process of steaming. These figures afford an additional argument in favour of always cooking potatoes in their skins.

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[1] Schopfer, W. H., and Jung, A., *C.R.V^{e}. Cong. int. Tech. Chem. Indust. Agric.* Schéveningue, 22 (1937).

[2] Pyke, M. A., *J. Soc. Chem. Ind.*, 58, 338*T* (1939).

Effect of Hexœstrol and of Alpha Methyl Stilbene on the Insulin Content of the Pancreas of the Rabbit

CONSIDERABLE evidence accumulated during the past two years shows that administration of natural and synthetic œstrogens increases the amount of insulin in the pancreas of the rat[1,2,3,4].

Further experiments on the action of the synthetic œstrogen hexœstrol, 4 : 4′ dihydroxy - α, β - diethyldihydrostilbene, on the insulin content of the pancreas of the rabbit have been carried out in this laboratory. Some experiments using α methyl stilbene, of which Dodds, Fitzgerald, and Lawson[5] have found that even very large doses are non-œstrogenic, have also been carried out. The results are summarized in the following table.

The two substances were dissolved in arachis oil and injected intramuscularly, over periods of 4–10 weeks.

TABLE 1.

Number of rabbits	Substance injected and average total dose	Body weight grams		Blood sugar mgm.%	Liver wt. grams	Testis wt. (2) grams	Adrenal wt. (2) grams	Insulin content in units gram of pancreas
		Init.	Final					
5 (1 female)	—	—	2,215	102	53·0	4·28	0·32	5·20
5 (1 female)	40 mgm. hexœstrol	2,386	2,306	98	44·2	1·27	0·31	8·85
3	320 mgm. of α methyl stilbene	2,190	2,323	84	66·0	4·35	0·47	24·49

From this table it is seen that the hexœstrol brings about atrophy of the testes and a moderate increase in the amount of pancreatic insulin. α methyl stilbene, on the other hand, increases the amount of pancreatic insulin to a marked degree, but has no effect on the testis weight, which result substantiates the finding of Dodds, Fitzgerald and Lawson that it is non-œstrogenic.

This report will be published shortly in the *Proceedings of the Linnean Society of New South Wales*.

I wish to take the opportunity of acknowledging my indebtedness to the Society for a scholarship grant, and to Prof. C. G. Lambie for his interest in this work.

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[1] Griffiths, M., and Young, F. G., NATURE, 146, 266 (1940).

[2] Marks, H. P., and Young, F. G., *Lancet*, 239, 710 (1940).

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A Census of Atmospheric Pollen

THE pollen content of the atmosphere is of interest in relation to general plant biology, the pollen analysis of peats and the study of allergic diseases such as hay fever and asthma. This subject was first investigated by Blackley[1] in Great Britain and has since been pursued on a wide scale in the United States[2]. So far as is known to us, however, it has received attention from only a very few workers on the Continent of Europe[3,4,5] and no such researches made in Great Britain (other than Blackley's) have been published.

We have recently completed a continuous investigation of the day-to-day changes during twelve months in the pollen rain at Llandough Hospital, Cardiff. Microslides previously coated with glycerine-gelatine containing fuchsin as described by Wodehouse[6] have been exposed, one every twenty-four hours, in a horizontal position under conditions which allowed reasonably free passage of air over them while affording protection from rain. Each slide was then mounted and all pollen grains under a $\frac{7}{8}$ in. cover-slip were identified so far as possible and counted.

The effective pollen season was found to extend from the middle of February to the end of October and to fall into three main phases, dominated by trees, grasses and herbaceous dicotyledons respectively. Of the trees, birch (Betula) gave by far the highest pollen count, 315 (63 per sq. cm.) on April 28–29, and yew (Taxus) gave the next highest, 142 (28 per sq. cm.) on March 26–27. Oak (Quercus) had a medium value, 92 (18 per sq. cm.) on May 16–17, as did elm (Ulmus), 83 (17 per sq. cm.) on March 27–28, and hazel (Corylus), 63 (13 per sq. cm.) on March 20–21, while alder (Alnus), 29 (6 per sq. cm.) on March 25–26, was relatively low and ash (Fraxinus), 12 (2 per sq. cm.) on April 11–12, was very low.

The grass pollen, from being negligible at the beginning of June, reached 386 (77 per sq. cm.) on June 11–12 and a maximum of 482 (96 per sq. cm.) on June 22–23. It was still 395 (79 per sq. cm.) on July 5–6, but toward the end of this month the number fell rapidly.

The phase of herbaceous dicotyledons, including chiefly the genera Urtica, Plantago and Artemisia and the family Umbelliferæ, gave low values only: Urtica 27 (5 per sq. cm.) on August 27–28 and 10 (2 per sq. cm.) on September 6–7, Umbelliferæ 10 (2 per sq. cm.) on August 27–28, Plantago 5 (1 per sq. cm.), and Artemisia 12 (2 per sq. cm.) both on August 20–21, while 10 grains (2 per sq. cm.) of the Compositæ—(Aster type)—were found on October 4–5. Pollen of some of these genera was found in larger quantities, however, during the grass season, namely, Urtica 58 (12 per sq. cm.) on June 19–20, Plantago 28 (6 per sq. cm.) on June 6–7 and Umbelliferæ 24 (5 per sq. cm.) on May 27–28.

Certain entomophilous pollens appeared in surprising numbers; for example, Cruciferæ 90 (18 per sq. cm.) and elder (Sambucus) 21 (4 per sq. cm.). In all, some sixty types of pollen have been recognized on the slides.

The detailed results of the year's work will be published elsewhere.

H. A. HYDE.

National Museum of Wales,
Cardiff.

D. A. WILLIAMS.

Llandough Hospital,
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Dec. 16.

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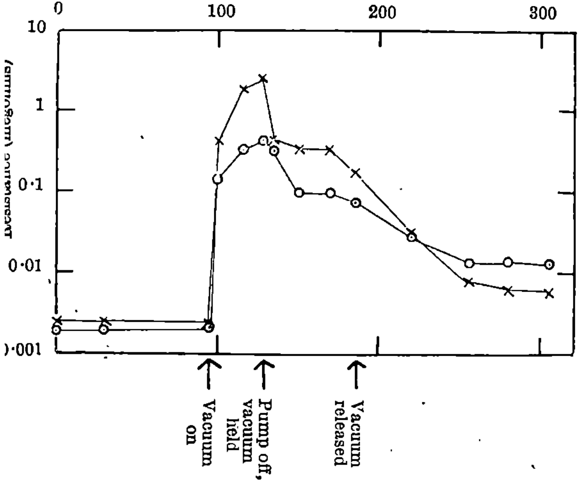
Electrical Resistance of Wood

THE electrical resistance of wood increases very rapidly with decrease in moisture content (grams of water present per 100 grams dry weight), so that, if two probes about 2 cm. apart are driven into the centre of a drying board, the resistance between the probes can be used as an indication of moisture content.

When beech wood is heated to just over 100° C. in a confined space at atmospheric pressure and the space suddenly evacuated, we have found that, for moisture contents between 30 and 40 per cent, the resistance between the probes increases by a factor of as much as 200 : 1. This is shown in the figure, where the resistance is plotted logarithmically. The increase might be interpreted as a rapid and large reduction in moisture content, but direct measurement shows, as one would expect, only a small reduction due to loss by evaporation.

That the apparent decrease in moisture content is not real is proved by readmitting air, or by maintaining the vacuum without further pumping. In either case, the resistance is found to fall gradually to something approaching its former value.



These observations suggest that the current path in moist wood is principally along the interior surfaces of the cells. If the current path were through the body of the cell walls, the sudden drying of the interior surfaces on evacuation could only cause an insignificant increase in the average resistance, whereas the observed resistance increases between one and two hundred times.

The effect appears to be confined to initial moisture contents below 30–40 per cent, that is, to the condition where the small local drying is not at the expense of the 'free' water present in the cell cavities, but has the chance of reducing the moisture in the surfaces themselves.

Measurement of the change in resistance of the wood as it is being heated up prior to evacuation shows that the temperature coefficient of resistance is negative, which indicates that the conduction is ionic as in a solution. The temperature coefficient is, however, too small to account, in terms of local cooling, for the large resistance change on evacuation.

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Dec. 10.

Human Activities and Soil Characteristics

ADDITIONAL evidence to that given by K. L. Robinson in NATURE of July 4 of changes in soil profiles of the New Forest since its occupation by early man has latterly come to light from under tumuli in the New Forest. These have been investigated archæologically by Mrs. Stuart Piggott, to whom I am indebted for the opportunity of seeing some of the exposures and discussing her findings, the early publication of which is anticipated.

The tumuli date, I am informed, from the Bronze Age, probably 1500–1200 B.C., and I know of no evidence of any earlier human occupation of this district. The sections were of pedological interest for their indications of changes of soil profile during the succeeding 3 to 3½ millennia of human occupation. Certainly throughout written history, and almost as certainly throughout pre-history, the hand of man has lain but lightly upon this hunting preserve cum free-range pastoral district, and it can have been subjected to nothing like the several drastic alterations of ecology implicit in the farming history of more normal agricultural districts.

One sectioned tumulus had a massive core of neatly piled sods of thick black heath peat, 3–4 ft. in thickness, above the old soil line and the central interment. These sods apparently represented the A_0 horizon from a mature and fully developed podsol profile, and adherent to each was its thick and well-developed bleached horizon (A_1); the core comprised quite two thirds of the volume of a cast or central mound about 40 ft. in diameter, and was topped over with 2–2½ ft. of sandy gravel. This latter appeared identical with the plateau-gravel subsoil underlying this heath. I should estimate the mound to have contained 90–100 cubic yards of compacted soil, probably more when loose and newly piled. This considerable weight of material was transported, one assumes, by hand in baskets, and therefore collected from a local source, in the narrowest sense of the word.

The present vegetation of this plateau site is Calluna, well scattered with ill-grown *Erica tetralix*, pervaded with dwarf *Molinia cœrulia* and a scatter of *Agrostis setacea*, all short of stature. Its modern profile, while podsolic, is unorthodox and not comparable with the ancient clear-cut and well-developed podsol beneath the tumulus, or of the sods at its core. It presents anomalous features as to which, since my war-time circumstances denied facilities for the necessary analyses, I cannot be at all particular. The differences most apparent to the eye are first, that the surface peat, A_0, is but ½–¾ in. thick instead of 1–2½ in., and secondly, in place of a well-marked pale bleached layer it has for A_1 an inch or two of black humic sand next below, passing fairly sharply into a dull medium yellow pebbly sand. To-day, therefore, it would not be possible to duplicate the sod-core of the tumulus within any reasonable carrying distance. One deduces that the ancient podsol profile has been robbed of its A_0 and A_1 horizons, and maybe of its B horizon during the thirty or so centuries of human occupation. The periodic heather burnings to freshen the grazing, and the now vanishing local manner of paring thin surface peats for domestic fuel, are probably responsible.

I agree with Robinson's conclusion that we have here a range of formerly mature podsols, mainly truncated through man's activities in the human era, and now in various phases of immaturity, undergoing regrading of a podsolic character.

A similar tumulus from a southern New Forest parish presented a different question in that the present conditions of the surroundings are of a moist heath with impeded drainage and gleyed subsoils of variable character, even more in contrast to the clear-cut podsol profile suggested by the sod-core, and the old soil-line beneath the tumulus. The original bottom of its surrounding ditch proved on excavation to be considerably below the present water-table of the site. The subsidence which flooded the vales of the Solent and Spithead rivers and made Wight into an island is believed to have occurred in middle or later Bronze Age times, so it may be that earth movements or minor foldings related to that subsidence are responsible for this revolution in drainage conditions.

If a district by comparison so lightly pressed by the hand of man can present profile immaturity problems of this degree, how much more complex the undeciphered sequence of partial regradings confronting the pedologist in the soils of farming England with their history of transformations: from forest cover to open-field manor, from this to grass at the Black Death, thence to enclosed arable for the Napoleonic War, and so on. This profile immaturity due to centuries of relatively dense human occupation and changing land-utilization seldom receives adequate allowance in considering the late start and the difficult progress of pedological survey in Great Britain.

F. E. KENCHINGTON.

Brockenhurst,
Hampshire.
Dec. 4.

A Modified Calomel Cell for pH Measurements

THE present shortage of potassium makes it necessary that chemists should take every care that there is no undue waste of this material, and it seems to us that with the large number of workers using the saturated calomel electrode[1] for making *p*H measurements, there must be a considerable loss of potassium chloride resulting from the frequent flushing of the liquid junction. The use of normal and decinormal potassium chloride cells would do much to avoid this waste, but they are neither so quickly prepared nor is the conductance of the cells so good as that of the saturated type.

We have experimented with a saturated calomel cell in which the potassium chloride has been replaced by sodium chloride, and it was found that well-defined potentials are obtained. The potential of the sodium chloride type of cell referred to the normal hydrogen electrode is a little lower than the potassium chloride cell, but there is not likely to be any inconvenience arising from this difference.

Saturated sodium chloride cells were made up by us and tested independently against saturated calomel cells of the conventional type. The sodium chloride cell had a potential of 245·8 mv. at 20° C.

It is well appreciated that for precise work in physical chemistry the potassium chloride cell is better, but there must be many hundreds of workers making routine *p*H measurements of a lower standard of accuracy where slight errors due to the difference in ionic mobilities are unimportant; further, there is the saving of potassium chloride and also of expense.

Further work on the potential and the temperature coefficient of the cell is being undertaken to assess the value of this cell for more precise work.

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London, N.10.

JAMES E. PAGE.

Chemical Research Department,
Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
Dec. 21.

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[1] Clark, W. H., "The Determination of Hydrogen Ions", 3rd ed. (Baltimore: Williams and Wilkins Co., 1928).

Newton and the Apple

IN my recent address on Newton to the Royal Society, a version of which was published in NATURE of December 19, I stated that the story of the apple first appeared in the second edition of Voltaire's "Elémens de la Philosophie de Neuton", printed in 1741. The point which I had in mind was that the story is not given in the first edition of that book which appeared in 1738.

Mr. Arthur Hawkes, borough librarian of Wigan who organized the effective Newton exhibition recently held in that town, has written to me pointing out that the story was printed by Voltaire in 1733 in his "Lettres sur les Anglais", which appeared in an English version in the same year. The point seems of sufficient interest to warrant this note. The publication by Voltaire in 1733 makes the omission in the first edition of the "Elémens" still stranger.

E. N. DA C. ANDRADE.

The Athenæum,
London, S.W.1.

ABSOLUTE TIME AND SPACE

By DR. G. BURNISTON BROWN
University College, London

"Yet the thing is not altogether desperate."
—NEWTON.

SINCE the last centenary of Newton's birth, his philosophy has been assailed with more vigour than in any other period since the first. Those who defended him against the Continental mathematicians of that time used the robust language of their day: James Bernoulli was a "boasting mathematical bully"; Leibniz "as dogmatical as if he had been originally one of God Almighty's privy council", and so on. In the tercentenary year, it may be worth while to inquire anew into the position of two of Newton's postulates which have come most under fire from Continental attack.

Absolute time, Newton thought it necessary to distinguish because the "vulgar" were liable to associate time only with the periodic behaviour of certain material systems. But the sensation of the passage of time is independent of the motion of any particular object and so the definition of time could not be made in terms of such a motion. Periodically recurring mechanical phenomena had, of course, to be used in order to introduce numbers as symbols for time intervals experienced in consciousness (Newton mentions the day and year, and Galileo used his pulse and water clocks); but these intervals were corrected according to theory built upon the assumption (in the case of the large time intervals) and the conscious awareness (in the case of the shorter ones) that the corrections, if any, would be very small. In this way laws were discovered which enabled a time scale to be developed which is independent of the behaviour of any particular body in the universe. This is the time scale which we still use to-day, and is possibly what Newton had at the back of his mind when he distinguished between "absolute, true, and mathematical time" and "relative, apparent, and common time".

Absolute space was postulated by Newton as existing, like absolute time, "without regard to anything external". Absolute motion is the translation of a body from one point to another in absolute space, and absolute motion may be distinguished by its "properties, causes, and effects". Newton's illustration of the water in the rotating bucket is well-known. This experiment shows that relative rotation of a small adjacent mass (the bucket) produces no centrifugal force on the water, but it does not altogether rule out the relative motion of distant large masses (the stars). This is emphasized by Newton's critics, but they do not tell us that Newton saw the difficulty himself and suggested a test which would decide the matter. That is why the position "is not altogether desperate". Newton suggested that "two globes, kept at a given distance one from the other by means of a cord that connects them", should be revolved about their common centre of gravity, and the tension in the cord measured when they were alone in an "immense vacuum", and then again measured when they were surrounded by "some remote bodies—that kept always a given position one to another, as the fixed stars do in our regions". If the force remained unaltered, we could conclude "the motion to be in the globes, and the bodies to be at rest"[1].

Physicists may vary in their opinion as to the result of such a test, but although the experiment is impracticable (unless the recession of the galaxies were to produce some change over a long period), it is not meaningless. It is curious, therefore, that Mach should quote pages from the "Principia" and yet stop quoting at the very point where the description of the crucial experiment above begins[2]. Continental relativists have followed Mach in ignoring this part of the "Principia" and they advance an epistemological argument saying that only "observable facts of experience" can be used as causes[3]. This would seem to rule out most of the causes used in physical theory, including the electron and the Heaviside layer, but without pursuing this point let us see what cause is put in the place of Newton's absolute space.

According to these critics, the cause of the bulging of rotating bodies must be distant masses. The use of the word 'must' looks as if they have left the inducto-deductive empiricism of Bacon and Newton and have returned to the compulsive categories of medieval logic. Misunderstanding Newton's famous "Hypotheses non fingo", some accuse him of not carrying out his own precepts. It is interesting to examine how far their own procedure is better in this respect. Passing over the almost universal use of unobservable space-time as a cause and saying that the motion of bodies is due to the curvature of space-time, let us ask whether these 'distant masses' can be observed. There are, of course, the 'fixed' stars, and the critics seem to conclude immediately that they are the distant masses the presence of which is compelled by their 'law of causality', and the relative motion of which produces centrifugal force.

Now Einstein's law of gravitation allows us to calculate the effect of relative motion on the force between masses, so that the next step was obviously to see whether the hypothesis of the relative motion of the known stars was sufficient to account for the bulge of the earth's equator. But for an examination of this point we have to turn to one of Newton's countrymen, and it leads to the conclusion that "the centrifugal force could not be produced by the motion of the stars, so far as they are known"[4].

Newton's absolute space is, therefore, not so easily dismissed, and the rather superficial epistemological 'principle of the law of causality' leads to the postulation of great masses for which there is no evidence in observation. It is true, of course, at the present time, that the larger the telescope the greater the number of distant stars seen, and thus it can be imagined that this number will increase, but those who hold such a law of causality cannot employ imaginary causes.

A choice philosopher in the tercentenary year of Newton's birth, when seeking for the reason for the bulging equator, must therefore choose between the following hypothetical causes: (1) The absolute space of Newton. The test which prevents it from being a physically meaningless concept cannot be performed. (2) The 'distant masses' of the relativists. The quantitative test which general relativity theory suggests shows that these distant masses are not the known fixed stars. These distant masses, therefore, are not 'observable facts of experience'. (3) The known stars. If the experimentally observed stellar masses are the cause, then the law of gravitation is not that of the general theory of relativity.

The problem of centrifugal force remains a fascinating one, and if the third cause above is ultimately adopted, it will certainly take a good deal of believing. This is because, if relative motion of masses be the cause, then masses at millions of light-years distance must be supposed to be effective whereas neighbouring masses produce no observable change. The behaviour of a gyrocompass in a submerged submarine is quite unaffected by the large masses of sea-water with various relative motions by which it is surrounded, and yet we must suppose it sensitive to the spiral nebulæ, α Piscium, β Leonis, γ Cygni, δ Herculis, ε Tauri, plus old Ursa Major and all!

To Newton, God was the origin of all things and "by existing always and everywhere, he constitutes duration and space". In Newton's mind the notions of absolute time and absolute space were undoubtedly mixed with pious considerations which no longer enter natural philosophy. Yet if absolute time means time the intervals of which are independent of the motion of any one body in the universe, and absolute space means a referent which is not obtained by taking any one body of the universe as being at rest, then absolute time and space are still the foundation of physical measurement to-day.

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[1] Newton, "Principia", 1, 13 (Motte's Translation, 1803).

[2] Mach, "The Science of Mechanics", 229 (1902).

[3] Einstein, "The Principle of Relativity" (Translated by Saha and Bose, 1920).

[4] Eddington, "Space Time and Gravitation", 153 (1920).

A NATIONAL SCHEME FOR HOLIDAY CENTRES

In the broadsheet "Planning for Holidays" (No. 194), Political and Economic Planning directs attention to a problem which may easily become acute, if not dangerous, immediately after the War, unless at least some effort is made to handle it now. The subject of holidays with pay enters into industrial relations, education and the social services, as well as forming an important part of a national health policy.

Only about four million out of about 18½ million insured workers in Britain in 1937 were entitled to holidays with pay, with about 750,000 salary earners with more than £250 per annum, but by March 1938 the number of insured workers with paid holidays had risen to about 7¾ millions, and when the Holidays with Pay Act was passed in July 1938, the Government's policy was that, after an interval to allow the extension of holidays by collective agreements, legislation should be passed in 1940 or 1941 making paid holidays compulsory throughout industry. The number of persons actually taking a holiday of one or more weeks away from home in 1937 has been estimated at about 15 millions out of a population of 46 millions. For the immediate post-war period, an estimate of 30 million holiday-makers in the first year after the War and towards 45 millions in successive years is not unreasonable. To meet this demand, holiday accommodation must be increased and an effort made to alter both the custom and the necessity which now concentrate the holiday exodus from the towns in the months of July and August, and especially in the Bank Holiday week. The potential peak of five millions seeking accommodation at one time could, it is estimated, be reduced to between 2 and 4 millions by spreading holidays between May and October.

The staggering of holidays is also important in its bearing on the cost of accommodation, but staggering is primarily a matter for industrial co-operation and for the help of the education authorities in timing school holidays. Moreover, forethought and planning will also be required if the greater demand for holidays is to be prevented from doing irreparable harm to the countryside and seriously interfering with the enjoyment of all. The War, by halting the spoliation of the coast of Britain, for example, has offered an opportunity of checking it permanently.

The urgency of this aspect has been stressed in the second report of the Coastal Preservation Committee, which appeared last October. The preservation of the coast is regarded as an essential item in a national policy for maintaining the beauty of the country; the scientific interest of the coast is an additional reason for its protection. Such preservation cannot be effectively carried out by the local authorities, and the report is in full agreement with the Scott report as to the necessity for immediate national planning, and that coastal preservation should be primarily a responsibility of the State. Coastal planning should include a belt extending sufficiently far inland to preserve the natural features of the general coastal landscape. There should be adequate provision for public access both to and along the shore and coast. Further, the right of the public to the free enjoyment of the foreshore for general recreation should be legally and practically established. Due allowance in planning the coastal belt should be made for probable losses through erosion, and the interference with public access to coastal areas for national defence purposes terminated as soon as military necessity allows.

According to the Planning broadsheet, the immediate post-war problem of holiday accommodation could be met by the conversion into holiday centres of some of the industrial hostels and other suitable war-time Government sites. The former include the Royal Ordnance Factory hostels, with a possible maximum of more than 41,000 places; the industrial hostels controlled by the National Service Hostels Corporation, with nearly 40,000 projected places in fifty-eight hostels; the temporary hostels outside target towns to house temporarily bombed-out workers and families with more than 50,000 places in seventeen hostels; and the three hundred rural hostels for agricultural workers with about 12,000 places. Although much of the accommodation will be in places not well chosen for holidays, more than half may be in suitable districts, and while other claims of comparable social importance may be advanced, it is hoped that a fair proportion will be allotted for holiday centres.

It is estimated that the Service camps have a capacity considerably exceeding that of any other type of war-time accommodation. Some of this will be retained for Service use, but some of the land occupied will be too valuable to retain for camps. Of the rest, much will be unsuitable for holiday requirements, but there should be a considerable useful residue adapted for temporary or permanent holiday use. Another possible source is in the large country houses no longer inhabited by their traditional owners, the expense of upkeep of which may prove progressively onerous. If the State were to acquire them, they could be maintained as people's holiday centres, a house forming a nucleus with annexes in the grounds if necessary.

The new holiday centres might be placed under the management of a semi-public body of the type of the National Camps Corporation or the National Service Hostels Corporation. Such a National Holiday Centre Corporation would be responsible for maintaining good standards of holiday provision at minimum prices at the centres under its control. Various forms of management might be tried experimentally, including indirect management through non-profit holiday organizations which would be free to run the centres in their own way, subject to inspection and to general conditions as to charges and standards. The Corporation might be assisted by an advisory committee representing the consumers and the experience of voluntary bodies concerned with workers' holidays.

COLONIAL RESEARCH IN THE BRITISH EMPIRE

THE survey of Colonial research in the British Empire prepared by Dr. Lucy Mair (*Agenda* for October) is of particular interest at the present moment. Under the Colonial Research Committee appointed in June 1942, a comprehensive survey is at present being made, as the first work of the Committee, of the facilities existing in Great Britain and the Colonial Empire, both for research and for the training of research workers. Pointing out that research in the Colonial field has tended in the past to be directed to the overcoming of practical difficulties that have already been encountered, Dr. Mair emphasizes that the present demand for a planned and consciously directed welfare policy is not a demand for something entirely new, but for more effective measures in the pursuit of aims already accepted. In regard to research by administrative officials, while those responsible for the conduct of policy in the Colonial Empire are fully aware of the need for knowledge of every aspect of the lives of its native populations, such inquiries, often limited in scope by the difficulty of finding time for them amid the pressure of other work, and carried out by those who have no specialized training in research in the elevant subjects, have not had a scientific value on level with that of work done by trained specialists evoting their whole time to research.

In social anthropology, the London School of Economics, where B. Malinowski held the chair rom 1926 until 1942, is the centre for this work in Great Britain. A great expansion in research was made possible by the Rockefeller Foundation which, after adding social anthropology to the subjects qualifying for its research fellowships, made a enerous grant to the International Institute of frican Languages and Cultures. The latter body om 1931 until the outbreak of war played a leading art in financing the training of social anthropologists and research by them in Africa. Chairs of ocial anthropology have been founded at Cape own and Sydney, and research workers trained at hese universities, and also at the Department of African Studies of the University of the Witwatersnd, have undertaken field-work in the adjacent olonial areas of Africa and the Pacific. While such ild-work is in suspense, a special advisory board in olonial studies constituted in 1941 has undertaken review for the University of London of the achievements and potentialities of the various social sciences in regard to Colonial research.

At the London School of Economics a Colonial Research Division has been set up to co-ordinate work on the various subjects which have Colonial aspects. Linguistic research in Colonial areas of a most practical kind is the work of the School of Oriental and African Studies (University of London), while the Colonial Department of the University of London Institute of Education has as its primary object the training of teachers for work among Colonial peoples but has also encouraged research on educational problems. The Oxford University Social Studies Research Committee organized in 1938 a co-operative expedition to Kenya, in which two anthropologists, an expert in Colonial administration, an economist and a geographer collaborated. The principal centre at Oxford for sociological research on Colonial questions is now Nuffield College, where a programme of research has been organized including a study of the economic problems of Nigeria and the Gold Coast, a comparative study of the various political institutions which have been developed under British rule in tropical Africa, and a study of the institutions, official and unofficial, through which economic policy is formed and executed.

In addition to the universities, the International Institute of African Languages and Cultures was also in peace-time an important institution for the organization of sociological research in Africa, and the war has prevented the completion of a plan to establish in Northern Rhodesia a Rhodes-Livingstone Memorial Institute as the first centre in Africa itself for the special study of problems arising out of the relations between local peoples and other races. Dr. Mair's survey also includes a brief reference to the London School of Hygiene and Tropical Medicine and the Liverpool School of Tropical Medicine, as well as to other medical research institutes in the Colonial empire where research in tropical medicine, in nutrition and in other health matters is carried out.

There are numerous institutions in the Colonies and in Great Britain which are concerned with agricultural and veterinary research and assist Colonial research workers with information and technical advice. Fishery departments have made surveys of local resources in Palestine and in West Africa, while in Malaya the Fisheries Department has concentrated its attention on raising the efficiency of this native industry. In the Colonial empire the most extensive forestry research has been done in Malaya by a well-equipped Forest Research Institute. The principal centre for forest research in Great Britain is the Imperial Forestry Institute at the University of Oxford, while research on the utilization of forest products is carried out by the Forest Products Research Laboratory, Princes Risborough, and the Colonial Forest Resources Development Department. A considerable amount of research has been carried out on the mineral resources of most Colonies by the geological departments, as well as by mining and oil companies, and this work has the assistance of the Mineral Resources Department of the Imperial Institute. At the present time, research on technical subjects has run far ahead of the study of social and economic problems, and Dr. Mair suggests that the disproportion may be corrected by the influence of the new Colonial Research Committee, on which both the social and the natural sciences are represented.

EDDY CURRENT LOSSES IN SINGLE-CONDUCTOR LEAD-COVERED CABLES

In a paper entitled "Eddy Current Losses in Single-Conductor Paper-Insulated Lead-Covered Unarmoured Cables of a Single-Phase System" (*J. Inst. Elec. Eng.*, **89**, Pt. 2, No. 12; December 1942), Dr. A. H. M. Arnold gives the results of an experimental investigation made at the National Physical Laboratory on cables carrying A.C. at power frequencies. Measurements were made with single-phase current on two parallel, 1·4-sq. in. cables forming go and return conductors. The total eddy-current losses are divided into four parts, namely, skin effect in the core, proximity effect in the core, proximity effect in the lead sheath, and circulating-current losses in the lead sheath when they are bonded together. Each of these is dealt with separately on a theoretical basis, and formulæ are then put forward for estimating the A.C. resistance of a cable from the design data; these formulæ are shown to give good agreement with the experimental figures.

The report is an official communication (Ref. *F/T78a*) from the British Electrical and Allied Industries Research Association and, together with an earlier one (Ref. *F/T55*), permits the following general conclusions to be drawn.

The losses in the core due to spirality effect and in the sheath due to skin effect can be neglected. The loss due to skin effect in the core is substantially the same as that due to skin effect in a solid round conductor of the same D.C. resistance per unit length, and was found to be calculable to within 1 per cent of the total losses by means of a well-known formula. The loss due to proximity effect in the core is less than that due to proximity effect in a solid round conductor having the same D.C. resistance per unit length on account of the higher resistance offered to the proximity eddy currents in a cable which have to flow from strand to strand. A previous formula for proximity effect in solid rods may be used for stranded conductors, provided a conductivity lower than the true conductivity of the copper is assumed; a figure of about 75–80 per cent of the true conductivity should be assumed.

A theoretical formula by H. B. Dwight for the losses due to proximity effect in the lead sheath was found not to be sufficiently accurate on account of its neglect of the modification due to the proximity effect in the core. An empirical factor has been added to Dwight's formula which increases its accuracy considerably. The loss due to circulating currents in the lead sheath was found to approximate closely to that obtained from the formula given in the report, except for cables very close together. At close spacings, the actual loss is less than that calculated, on account of the reduction of the mutual inductance between core and sheath due to proximity eddy currents in the core. This loss reduction can be allowed for largely by assuming that the proximity loss in the lead sheath is non-existent when the sheaths are bonded together.

The complete formulæ put forward for estimating the total losses in a cable, with the sheaths bonded or unbonded, give good agreement with the experimental results. At a frequency of 50 c./s., the maximum discrepancy between the computed and measured losses is less than 1 per cent for a 1·4-sq. in. cable, and at 100 c./s. the maximum discrepancy is 3 per cent. Tables are given by means of which the ratio of A.C. losses to D.C. losses of any standard cable can be read at a glance for the standard frequency of 50 c./s.

FORTHCOMING EVENTS

Monday, January 18

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore; London, S.W.7), at 8 p.m.—Capt. W. E. D. Allen: "Ethiopian Highlands".

Tuesday, January 19

INSTITUTION OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 2 p.m.—Mr. George Ellson: "Modern Trend of Railway Engineering Practice".

Wednesday, January 20

FOLK-LORE SOCIETY (at the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. J. D. Rolleston: "The Folk-Lore of Children's Diseases".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2) at 1.45 p.m.—Prof. W. E. S. Turner, F.R.S.: "New Uses for Glass".

INSTITUTE OF PHYSICS (at the Royal Institution, Albemarle Street, Piccadilly, London, W.1.), at 6 p.m.—Dr. R. K. Schofield: "The Distribution of a Liquid in a Pore-Space."

Thursday, January 21

INSTITUTE OF FUEL (JOINT MEETING WITH THE CHEMICAL SOCIETY, THE INSTITUTE OF CHEMISTRY AND THE SOCIETY OF CHEMICAL INDUSTRY) (in the University Chemical Department, Woodland Road, Bristol), at 5.30 p.m.—Dr. E. W. Smith: "Fuel Economy and the Chemist".

Friday, January 22

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. S. A. Couling: "Practice and Experience in the Production of High-Speed Helical Gears, *with special reference to the Elimination of Transmission* Noises".

APPOINTMENTS VACANT

APPLICATIONS are invited *for the following appointments* on or before the dates mentioned:

LECTURER TO TEACH CHEMISTRY in the Department of Chemistry and Metallurgy, Coventry Technical College—The Director of Education, Council House, Coventry (January 20).

EDUCATIONAL PSYCHOLOGIST—The Secretary, Royal Victoria and West Hants Hospital, Bournemouth (January 22).

SPEECH THERAPIST for Speech Clinic in Harrow—Mr. C. W. Radcliffe, 'R.2', Clerk to the County Council, Guildhall, Westminste London, S.W.1 (January 23).

TEACHER OF MECHANICAL ENGINEERING—The Principal, Wolverto Technical College, Wolverton, Bucks (January 25).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk Municipal Offices, Grimsby (endorsed 'Borough Electrical Enginee and Manager') (January 28).

SPEECH THERAPIST—The Director of Education, Peel Stree Huddersfield (January 30).

EDUCATIONAL PSYCHOLOGIST—The Secretary-Superintendent, Belfast Hospital for Sick Children, 180 Falls Road, Belfast (February 1

ASSISTANT TO TEACH MATHEMATICS—The Registrar, Wimbledo Technical College, Gladstone Road, London, S.W.19 (February 1).

SPEECH THERAPIST—The Acting Director of Education, Educatio Offices, Becket Street, Derby.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A Mathematical and Physical Sciences. Vol. 61, Part 3, No. 2 Sylvester's Unravelment of a Ternary Quartic. By W. L. Edg Pp. 247–259. (Edinburgh and London: Oliver and Boyd.) 1*s*. [28

Transactions of the Royal Society of Edinburgh. Vol. 60, Part No. 18: The Conducting System of the Marsupial Heart. By Pr D. M. Blair, Prof. Francis Davies and Dr. E. T. B. Francis. Pp. 62 637+2 plates. (Edinburgh and London: Oliver and Boyd.) 1*s*. 9 [28

The Stammering Child and How he can be Helped. Pp. 4. 2 *Should we have a Baby in War-time?* Pp. 2. 2*s*. per 100. (London National Baby Welfare Council.) [29

Other Countries

Commonwealth of Australia: *Council for Scientific and Industr* Research. Bulletin No. 149: Production of Dried Grapes in Murr Valley Irrigation Districts, 2: Irrigation, Drainage and Reclamatio By A. V. Lyon and A. L. Tisdall. Pp. 35. (Melbourne: Governme Printer.) [28

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A WORLD AUXILIARY LANGUAGE

It has been well said that all men desire peace but very few desire those things which make for peace. Among "those things" must be placed an international auxiliary language which, though of almost hoary antiquity, has never interested more than a fraction of civilized mankind. The reasons for this apathy are many, but among the chief are : the imbalance between the self-assertive and combative instincts and the gregarious and co-operative instincts ; mental sloth ; patriotic bias ; and the obduracy shown by innovators in resisting reforms.

Civilized nations have already adopted common signs and code languages for use in mathematics and science, music, marine flag-signalling and wireless messages. No one would suggest to-day that people of differing nationality should employ different languages for such purposes, and thus it is that musicians can play from scores produced by other nationals. Ships' officers can send messages of considerable length and complexity by means of Morse and other signals. All nations understand the same numerals, the same chemical, mathematical and other technical signs. But, when the users of these convenient inventions wish to communicate by word of mouth or in writing, they are often unable to do so unless they happen to understand the same language. Is it not time that this state of affairs was abolished, and international intercourse put on a basis of facility and fluency ? The modern world is, indeed, somewhat behind the Middle Ages, when a sort of conversational Latin provided a means of direct communication between educated people. Despite Hegel's dictum that history teaches only that history teaches nothing, it seems more than likely that when the present War ends we shall see a strengthening of democratic ties and tendencies and a revival of the international language problem, just as we did after the War of 1914–18. The subject has already been raised by Sir Richard Gregory (NATURE, 150, 622 ; 1942), in the report of the British Association Committee on Post-War University Education (NATURE, 150, 716 ; 1942) and elsewhere.

The history of the movement is too long to justify more than a passing notice of a few of its salient features. The first recorded attempt to construct a world language was made some six hundred years ago by the Abbess Hildegarde, of Rupertberg, near Bingen. She devised a system with an alphabet of thirty-two letters on lines which did not appear again until the latter part of the nineteenth century. Then followed Descartes, in 1629, who elaborated a series of conditions which any universal language must satisfy. He had in mind a philosophical language not linked to natural languages ; and this was also the conception of Leibniz, who invented a system of classifying ideas into main groups and sub-divisions, using numerals allied with nine consonants and five vowels as symbols, and thus in a measure anticipating the modern Dewey system of library classification. Leibniz also appears to have been the first to foresee the possibility of a synthetic language constructed from word-roots in natural languages. In 1795, the third year of the French Revolution, Delormel presented to the National Convention a project based on the decimal system, which aimed at "uniting the peoples by the delicate bonds of brotherhood" through the medium of a common logical and regular language, because "national languages present at each step irregularities which make them difficult and demand a long time to learn". Coming to more modern times, in the 1880's, J. M. Schleyer, a Roman Catholic priest, succeeded in constructing a new language, Volapük, by building it up from the roots of words in existing languages, but after some progress the effort failed because the grammar was very involved; it was very difficult to identify the distorted monosyllabic roots, and the inventor refused to countenance any attempt at reform.

In 1887 appeared a much simpler and more flexible language, Esperanto, which has lasted much longer and attained far more success than any of its predecessors. Esperanto derives its vocabulary almost entirely from Western languages, its grammar is very simple, its pronunciation euphonious, and it lends itself easily to the introduction of new words. There may be certain defects in it, such as the arbitrary choice of roots from existing languages, which makes Esperanto easier to read than to speak, but experience has shown that it is perfectly practicable: people attending Esperanto congresses from all parts of the world, and meeting for the first time, converse fluently in it. Propaganda has now been conducted systematically and intensively for about fifty years, and on the whole has not been seriously prejudiced by the efforts of rival bodies, like those professing Ido, Esperantido and Occidental. The number of people who speak Esperanto is estimated at 1½–2 millions, though there are no reliable statistical data on the subject.

In 1919 the International Research Council recommended the appointment of an international committee to investigate the question, and in the same year the British Association appointed the committee which, in 1921, reported in favour of a neutral synthetic language. In 1920 the subject was discussed at the General Congress of the World Union of International Associations, and a resolution in favour of Esperanto was passed, with one dissentient. In 1922 a report was presented to the Third Assembly of the League of Nations, which was in general agreement with the findings of the British Association Committee, except that it declared outright in favour of Esperanto. A Red Cross conference, held in 1921, also voted for Esperanto, and in November of that year the conference of the International Labour Office recommended to the administrative council of the International Labour Office that it should increasingly use Esperanto as a practical means for facilitating international relations. Governmental recognition and help has been accorded by Spain, Portugal, Bulgaria, Czechoslovakia, Germany, Austria, Finland, Brazil, China and Japan. In addition, numerous municipal, commercial and academic authorities have passed resolutions in its favour, and the Roman Catholic Church has on more than one occasion shown a friendly attitude. Among scientific bodies that have interested themselves in this language is the French Academy of Sciences, which in 1921 published a manifesto urging scientific workers to adopt it; it was signed by thirty-nine prominent members, including Berthelot, Lumière, Painlevé and the Prince of Monaco. But revolutions are not made by resolutions.

As an international language is essentially a democratic ideal, it is not surprising that when the Nazis came into power in 1933 they discountenanced the use of Esperanto; in fact, in 1936, Himmler issued a police decree ordering the dissolution of all international language societies in the Reich, and similar action was taken later in Austria and Czechoslovakia. When war came in 1939, international contacts were inevitably broken, but the ardent advocates of Esperanto have continued their efforts, though nothing has been heard of other language projects. The Army Education Service includes Esperanto among the subjects for postal study courses, and for several years past the Royal Society of Arts has held examinations in the language. It is, furthermore, taught in a number of schools, both primary and secondary, as a regular or optional subject.

As previously stated, the end of the present War may see a revival of interest in an international auxiliary language; if the outcome corresponds with our hopes, there will be a general resurgence of the democratic spirit, as opposed to the authoritarian, a greater recognition of the advantages of interdependence, and of the necessity for freer international trade and improved international communications. On the other hand, there is a danger that some of the liberated nations may be over-imbued with the spirit of nationality, that is, with patriotic bias, and will strive to maintain their independence, their institutions and their culture to a degree that will impair the spirit of mutual dependence (and especially if the proposal of federation does not fructify); but this impediment should not deter the adoption of a world language, if it be thoroughly understood that the language would in no case supplant an existing national language. A further impediment to realization would arise if any of the bigger nations were to insist on the general acceptance of its own national language. In the investigations made by the British Association Committee during 1919–21, it was found that with the exception of certain small countries in north-west Europe, commercial interests were all in favour of having their own national language adopted. This obstacle would be quite likely to arise among the Anglo-Saxon peoples, whose prestige and influence would be greatly enhanced by a successful war. The English language, with its obvious excellencies, is far too difficult for use as an international auxiliary language, and the general adoption of an easier but debased form of it would in the end debase the national language itself.

The problem, being essentially an international one, would best be handled by an international body, for example, a reformed League of Nations; but such a body would be effective only if it gained the full support of its constituent members, and therefore, apart from private enterprise, individual governments would have to take steps to stimulate public interest in the question and eventually to canvass public opinion. Though the final decision as to the desirability of an international auxiliary language, and the language to be adopted, would rest with the international authority, each national representative should be in a position to declare unequivocally in favour of that chosen by his own country.

The problem, therefore, resembles nearly all other problems relating to human betterment, in being fundamentally an educational one. It would primarily concern governmental education departments, and these would be guided by an impartial commission consisting of representatives of all the main national activities: industry and commerce, science and its applications, letters and linguistics, schools and universities, and the great professions. Once an international auxiliary language had been chosen, the question of how and when it should be introduced would arise, and also whether or when instruction in it should be made obligatory. If the language were really simple, its introduction into primary and secondary schools should not lead to further congestion of the curricula. As a rule the very young learn readily to speak a new language, if they live in an atmosphere of it, but they forget it soon, and often completely, when they have no further use for it. A thorough knowledge of a new language is usually acquired very slowly by school children up to about sixteen or seventeen years of age, but after then, especially if they see the need for it and are given facilities for practising it, acquirement is much more speedy. There is, therefore, much to be said in favour of the proposal made by the British Association Committee on Post-War University Education that the learning of an international auxiliary language would best be undertaken as a long-vacation study in the university (and presumably in evening classes by non-university students). But no lasting progress or success would be attained unless adequate facilities were provided for using the language, whether in reading, correspondence, or conversation, preferably with foreign people.

Those whose faith in a war to end war has been rudely upset, and those who hold that man's combative instinct is neither eradicable nor transformable, may yet be convinced of the practical utility of an international auxiliary language in everyday life. Research workers would surely welcome a single journal containing all the abstracts of original papers and also copies of important papers they may need in one international language; learned and technical societies could economize on the purchase of foreign literature; and the use of an international auxiliary language at international scientific congresses would enhance not only mutual comprehension, but also the good-fellowship that has been so marked a feature of such gatherings in recent years. The end of the present War should provide a unique opportunity for translating into effective practice this six hundred year old ideal.

DYNAMICS OF THE STELLAR SYSTEM

Principles of Stellar Dynamics

By S. Chandrasekhar. (Astrophysical Monographs sponsored by the *Astrophysical Journal*.) Pp. x+251+6 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1942.) 5 dollars.

As a subject progresses the attractive simplicity of the early researches gives place to laborious elaboration. In the last three years, Dr. Chandrasekhar has been very active in the mathematical development of stellar dynamics. The trend of his work may be judged from the fact that one contribution alone contains more than 1,800 numbered formulæ. There is no denying that this heavy method of attack can be justified; but it leaves us with the depressing feeling that the subject which began thirty years ago as a joyous adventure has reached a stage of uninspiring ugliness. We are the more grateful to Chandrasekhar that in his new book he has not allowed the subject to be crushed by an overweight of mathematical formulæ. The treatment is, of course, mathematical throughout; but it is mathematics of the methodological kind which the reader tolerates, not heavy algebra which he skips. The book fills an obvious gap in astronomical literature, and it should give a valuable stimulus to research. There are some omissions to which reference will be made later; but, if judged by what it contains rather than by what it leaves out, it is a very helpful synthesis.

There are five sections, dealing respectively with stellar kinematics, the rate of approach to statistical equilibrium, the main problem of the dynamics of a galaxy, the theory of spiral structure in galaxies, and the dynamics of star clusters. The treatment is usually well arranged. I have, however, one complaint to make. The author follows the practice of continually introducing fresh symbols, and his final formulæ are left in whatever stage of symbolism he happens to have reached. Consequently his results are usually cryptograms, of which the key has been cut up into little pieces and hidden in odd corners. This may not incommode the systematic reader overmuch, but a reviewer can only judge the progress that has been made by the enunciations of the problems solved; what the results amount to, and whether they reveal anything unexpected, he has no idea, since the author does not choose to tell him.

I shall here deal more particularly with the middle section on the dynamics of the galaxy, which is perhaps the most open to criticism. It seems to me to suffer from the lack of a defined practical aim, such as an observational result to be elucidated. The early development of galactic dynamics came about in a practical way. There were two rival views as to the nature of star-streaming—Kapteyn's hypothesis involving transverse streaming and Turner's involving radial streaming. Turner's hypothesis was less artificial, and the radial direction of streaming is now known to agree with observation; but it raised difficult dynamical questions—whether the radial orbits would involve an impossibly high congestion of stars at the centre, or whether the data would demand too eccentric a position of the sun. Even if no new questions suggest themselves to-day, the bearing of galactic dynamics on these older problems might well have been treated, especially because there has in the meantime been a great change in our knowledge of the dimensions and rotation of the galaxy. For example, Chandrasekhar rightly points out a fallacy in a theorem which I gave in 1915; and the correction makes the conclusion (that star-streaming in a steady system is necessarily radial) less general than has hitherto been supposed. But he does not take the opportunity of restating the position. Presumably it is still true that in a steady system with axial symmetry the velocity surfaces are confocal quadrics, and transverse star-streaming is rigorously excluded; but there is no mention of this. Again, later investigators have considered an expanding or contracting system especially with the view of explaining the apparent discordance between the vertex of star-streaming and the direction of the galactic centre; Chandrasekhar also admits a variation with time, but makes no reference to this question.

In galactic dynamics the stars are considered to move in the smoothed field of gravitational attraction of the system as a whole, the statistical effect of encounters being negligible. This formulation now seems so obvious that it may be forgotten that it was not the first stage of stellar dynamics. The fact is that the analogy between stars and the molecules of a gas was too enticing; and what was first looked for was an equipartition of energy. Misleading observational evidence of a correlation between masses and velocities of stars seemed to support this. The fallacious analogy might have endured much longer, but for the discovery of 'moving clusters' in which the stars have equal and parallel motions although they are widely separated in space. The most impressive of these is the Ursa Major cluster, which comprises stars in other parts of the sky, including Sirius. The realization that the time of relaxation to statistical equilibrium is extremely long (10^{14}–10^{16} years) was one factor in the change; another factor was the realization that the time of relaxation to dynamical equilibrium is remarkably short (10^8–10^9 years). We were thus led to contemplate the stellar system as dynamically in a more or less steady state, changing very slowly towards the ultimate statistical equilibrium, or more strictly towards an ultimate collapse and dispersal. But the most important factor which led to the formulation of galactic dynamics was that urgent questions relating to the star-streams demanded such a theory.

The obvious problem is to determine the possible states of motion of a galactic system governed by its own gravitational field. So far as I am aware, no solutions have been found except for a distribution of density with spherical symmetry; but this soluble case, besides being rather attractive mathematically, helps us to gain a better understanding of the whole subject. Although the progress has not been very great, it is scarcely justifiable to ignore it altogether. I do not think that Chandrasekhar even mentions the problem, at any rate in the section on galactic dynamics.

The problem which Chandrasekhar handles is one that was originally formulated by the reviewer in 1915 as a side-problem, namely, a sub-system moving in the controlling field of a larger system. Looming behind it, there is always a further problem as to how the equilibrium of the larger system itself is maintained; in particular, there is the question whether the particular gravitational field which the sub-system demands is such as could be furnished by any admissible form of larger system. Thus the theory is better adapted to prove that certain kinds of distribution (for example, transverse star-streaming) are impossible than to prove that certain kinds are possible. In short, the 'solutions' satisfy necessary, but not sufficient, conditions for physical application. The view of galactic structure current in 1915 gave reasons for treating a sub-system, with density distribution markedly different from that of the stars as a whole, which do not apply to-day; and the primary justification for the 'side-problem' seems to have disappeared. Nevertheless, it is probably the most practicable way of approaching the main problem of an oblate galaxy. I think that Chandrasekhar's most important advance is to show that, if differential rotation exists, the sub-system can only be in a steady state if the potential of the controlling system has axial symmetry. It is interesting to notice that the recognition of galactic rotation, which might seem to be an unwelcome complication in a problem which already over-taxes our powers, actually makes for simplification, since his theorem ceases to apply when the rotation vanishes.

The dynamics of a star gas and of an atom gas are strongly contrasted; but the complete theory of the galaxy must include them both. For the galaxy comprises a stellar system and a cosmic cloud. It is still uncertain which part has the greater mass. It has generally been assumed that the stellar system is the more massive; but if it turns out that the main part of the controlling gravitational field is due to the cloud, the problem of the equilibrium and evolution of the galaxy will be substantially modified, and presumably simplified. In either case there is an important condition which galactic dynamics ought to take into account. Although the star gas and the cosmic gas are semi-independent systems governed by widely different forms of dynamics, the rotation (both absolute and differential) is known to be approximately the same for both. It would seem, therefore, that the distribution of rotation has to be compatible with both kinds of dynamics. It is just possible that, so far as the practical problem is concerned, we have been beginning at the wrong end; and the true starting point should be a study of the forms of distribution of a rotating viscous gas.

A. S. EDDINGTON.

FRUIT CULTURE

Modern Fruit Production

By Prof. Joseph Harvey Gourley and Prof. Freeman Smith Howlett. (Rural Text-book series.) Pp. vii+579. (New York: The Macmillan Company, 1941.) 18*s.* net.

THIS book is quite frankly written for the professional horticulturist, the serious student and the progressive grower of the United States. But a study of the book shows how extremely diverse are the environmental conditions experienced on that continent and what a wide range of fruit—from berry fruits to grapes and from citrus to cherries—comes within its purview.

The authors fully realize the vastness of the industry for which they are attempting to cater, and point out that the United States was responsible over a six-year period (1931–36) for the production of no less than one third of the world fruit output. Very wisely, therefore, they make no attempt to present a mass of experimental data which would but serve to bewilder. Actually only fifty short tables in all appear on the 565 pages of exposition of general principles. There are in addition some eighty-seven pertinent diagrams and plates, which latter give a very good idea of the diversity of fruit-growing methods practised in the United States.

While the book contains more than seven hundred specific references to recent research, these are skilfully dovetailed into a clear account of up-to-date American practice. Where research in other countries, especially in Great Britain and the Dominions, bears upon general horticultural principles, it is not infrequently quoted. Although it is claimed that "Pomology has developed into a science in its own right, similar in its fundamental background to other plant sciences", the difficulties of drawing conclusions of universal application upon complex, long-lived, extensive-rooted fruit plants, so subject cumulatively to environmental influences, are frankly stated. The authors put an unanswerable case for the abandonment of a search for rule of thumb methods and stress the need for an appreciation of all the interdependent factors which alone can guide cultural practices from year to year. The complexity of the factors involved in such problems as fruit bud formation, fruit set, alternate year bearing and storage quality is clearly brought out, and the relationship of the orchard practices of pruning, cultivating, manuring and fruit thinning—which are designed to control these tendencies—is developed in parallel. Indeed no one can read the chapters dealing with these subjects without feeling more competent to deal with the practical problems and more conversant with the underlying principles. For example, while the classical experiments of Kraus and Kraybill on the carbohydrate nitrogen relationships in the fruiting tomato plant are brought into line with Hooker's investigations on flower formation in the apple for the benefit of the student, the fruit grower is assured by the practical conclusion that it is the leaf surface of the plant which is of paramount importance in bud differentiation, and he is directed to the alternative ways of maintaining or improving leaf surface, which can be appropriately chosen according to the condition of his orchard. The investigator is tempted to explore further the suspected presence of flower-producing hormones.

The arrangement of the individual chapters is somewhat puzzling to the European who, after reading Chapter 2 dealing with the "Fruit Plant and its Parts", is surprised to find that "Propagation and Stocks" are relegated to Chapter 15. Again, after reading about "Cultural Practices", "Fertilizers and Manures" and "Water Relations" in Chapters 6–8, disappointment is experienced that bare mention is made of Wallace's pioneer work on the diagnosis of nutrient deficiencies by leaf and growth symptoms. However, a handsome tribute to that work is only delayed until Chapter 14 which, incidentally, includes a useful summary of the symptoms of other 'physiological disorders'. It is realized that these seeming discrepancies are due to local emphasis in a country where nitrogen and moisture deficiencies have in the vast majority of cases been the limiting factors in orchards, and where large-framed trees planted 32–40 ft. apart have been the unquestioned order of the day. A few more specific cross-references in the earlier chapters would, however, not come amiss.

Some readers will be surprised to learn what a comparatively minor role pruning is given in the orchard practice of the United States to-day, but the statement that many growers are now pulling out their apple trees at 30–35 years old because of the reduction of fruit size and quality suggests that the pendulum may have swung too far in the direction of *laisser faire*.

Except in so far as diseases, pests and measures for their control affect 'tree condition', the authors have made no attempt to deal with pathological problems; consequently they have been able to cover the pomological field very fully and there are few established facts or practices which they have overlooked. Thus "Modern Fruit Production" should succeed in stimulating a much wider audience than it was designed to inform, and it will be welcomed as a clear summary of progress made in correlating the recent findings of horticultural science with economic fruit-growing practice.

The data collected by the Bureau of Economics of the U.S. Department of Agriculture, and supplied in Chapter 1, about the varieties, ages and localities of some hundred million bearing and non-bearing apple trees in the United States, should give food for thought to the fruit industry of Great Britain, which has no reliable statistical basis upon which to reconstruct its future.

R. G. HATTON.

FOREST TREE SEED

Forest Tree Seed of the North Temperate Regions, with Special Reference to North America

By Henry Ives Baldwin. (A New Series of Plant Science Books, Vol. 8.) Pp. xvi+240. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1942.) 4.75 dollars.

THE regeneration of forests depends, in the first place, on the seed of trees. The conditions which influence the production and germination of seeds, and the effects of environmental and hereditary factors on the nature of the plants they produce, and thus on the whole future of the crop, have been the subjects of extensive research and inquiry for many years. The results of original experiments have often a very limited circulation, reports are often published in obscure journals and the research worker and the practising forester have seldom either the time or the opportunity to search for them. It is, therefore, highly desirable that a synthesis and a digest of this extensive literature should be produced, and the present work meets this requirement very successfully.

A great deal of the interest in tree seeds has arisen from the expansion of artificial regeneration, afforestation and ornamental planting, so that it is not surprising that the greater bulk of this book is concerned with the artificial treatment of seeds, such as collection, storage, extraction, cleaning, testing, etc. Nevertheless, these are related to the reactions of seeds to their environment, and the author has kept this relationship to the forefront throughout.

The chapter on "Extraction and Cleaning" is particularly interesting. Descriptions of many kinds of apparatus are given, with diagrams, and the working of each is explained and commented upon, both from the point of view of their effect on the seed and their economic efficiency.

The subject of seed provenance is discussed in a chapter in which the work of investigators on some of the most important European and American species is summarized. To the British reader it is regrettable that that of Münch, Rübner and others on the European larch is not included, but a selection had to be made and, for American readers, this species is of minor importance.

Though the artificial treatment of seeds and the requirements of artificial regeneration receive so much attention, the author rightly stresses the fact that the problems of natural regeneration are also bound up with seed production, storage, dispersal and germination, as well as the influence of biotic, climatic and soil factors on the survival of seeds in a viable condition and on the establishment of the seedlings as independent organisms. All these matters receive consideration in this work. The method of the author is to devote a chapter to each branch of the subject, giving a general account of the points investigated by different workers, with a summary of the most important contributions. Then a general review of the position is given, indicating points on which agreement is reached and those in which further investigation is called for. A very full bibliography is added to each chapter. At the end of the book is a useful glossary of seed terms with their French, German, Danish, Norwegian and Swedish equivalents, and a list of authors mentioned in the text.

The work will be indispensable to research workers in the field of tree seed and very useful to practical foresters and members of the seed trade. It is not a handbook of tree seed, giving cut and dried information about individual species, but a reference book and a guide, not only to existing knowledge but also to the directions in which that knowledge should be extended in the future.

T. THOMSON.

NON-EUCLIDEAN GEOMETRY

Non-Euclidean Geometry

By Prof. H. S. M. Coxeter. (Mathematical Expositions, No. 2.) Pp. xv+281. (Toronto: University of Toronto Press, 1942.) 3.25 dollars.

THE philosopher Kant declared that Euclidean geometry was inherent in the human mind and expressed the truth about space. We now recognize that non-Euclidean geometry is equally valid as an abstract system, and that one particular form (due to Riemann) has more claim than Euclidean geometry to represent the properties of physical space. The transition from the old point of view to the new has revealed the true nature of geometry, and thence of mathematics in general, and has helped to build up the theory of relativity.

To survey their fields and build the pyramids, the Egyptians had a set of empirical rules, which the Greeks developed into a science. In particular, Euclid attempted to deduce the properties of straight lines and circles from certain definitions, axioms, and postulates. The axioms or "common notions" were regarded as self-evident truths, whereas the postulates were frankly assumptions, but most of them seemed so obvious that no one denied them. There was one exception, namely, the fifth postulate (often called the eleventh axiom): *If a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than two right angles.* For centuries mathematicians, while not doubting the truth of this postulate, objected to it as too complicated. It was hoped to prove it by showing that a contradiction would arise from denying it or one of its simpler substitutes, such as 'Playfair's axiom': *Two intersecting straight lines cannot both be parallel to the same straight line.* No contradiction was ever found. In 1823 Bolyai, and independently Lobatschewsky in 1826, worked out a system of geometry (now known as hyperbolic) quite as logical as Euclid's, but assuming that his parallel postulate was untrue! Similar results had been obtained by Gauss even earlier, but for fear of ridicule he did not publish them.

A much greater departure from the Euclidean geometry appeared in 1854, when Riemann, using the methods of differential geometry which Gauss had developed from land-surveying, introduced a geometry (now called spherical) in which there are no parallels, and two straight lines enclose a space! The relationship between the alternative geometries remained obscure until much later. Cayley (1859) showed that the 'metrical' properties of Euclidean space, such as distance and perpendicularity, could be derived analytically from the 'projective' (that is, non-metrical) properties of a certain conic called the "absolute". Klein (1871) developed this idea, and set up a general projective geometry, from which he obtained elliptic geometry (akin to Riemann's), parabolic (Euclidean), and hyperbolic. He also showed the existence of 'models' or correspondences, by which it could be deduced that one geometry is logically self-consistent if another is so. (Dr. Coxeter thinks that the only ultimate test of consistency is based on the properties of the physical world as interpreted by our senses.) More searching investigations into the logical structure of geometry were made by Pasch (1882) and Hilbert (1901). The word "axiom" is now used for an assumption concerning the relationship between certain *undefined* terms such as *point* and *straight line*, and there are an infinite number of geometries corresponding to the infinite choice of the set of axioms, which may be freely chosen as long as they are self-consistent. Naturally, those which agree closely with the properties of physical objects are of most interest, in particular Euclidean geometry because of its simplicity, and Riemannian because of its use in relativity.

Dr. Coxeter's book starts with an excellent introductory chapter, mainly historical. Chapters 2 and 3 are on projective geometry, and instead of defining polarity with reference to a conic, follow von Staudt by defining polarity as "a correlation of period two" and then look for a corresponding conic. Chapter 4 is on homogeneous co-ordinates. After these somewhat prolonged preliminaries, elliptic geometry is obtained from projective geometry, since every axiom of the former is valid in the latter. This idea is developed in Chapters 5, 6 and 7. In Chapters 8 and 9, Euclidean and hyperbolic geometry are derived from a general 'descriptive' geometry. The remaining five chapters are simpler, dealing with hyperbolic geometry in two dimensions, circles and triangles, a general triangle of reference, area, and Euclidean models. The book concludes with a bibliography and an index. It will appeal to those who have already a first acquaintance with the subject and are ripe for a systematic treatment.

H. T. H. PIAGGIO.

Soils and Soil Management

By Prof. A. F. Gustafson. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. viii+424. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 21*s*.

THIS book sets out to describe the principles of soil management from a practical point of view in a way that should be intelligible to the modern farmer or to students taking advanced courses in agricultural colleges. The author covers the whole field of soil management including, on one hand, such subjects as soil cultivation, erosion control, dry farming and irrigation and, on the other, fertilizers, manures and crop rotation. He naturally chooses most of his examples from the United States and tends to emphasize points of importance to that country, but this restriction does not detract from the book's educational value for students outside that country, although some of the detail will naturally not apply.

The main criticism of the book is that the scientific principles underlying the practice are not always clearly brought out. This is especially unfortunate in those subjects in which there is no traditional background of knowledge to help the reader pick out those particular details of practice that would be applicable outside the agricultural regions described. A minor criticism is that the introductory chapters on what is often called soil science, namely, soil formation, soil micro-organisms, soil organic matter and soil water are too sketchy to be really helpful, and, in addition, that on soil water is not up to date. The main part of the book, on soil management proper, does not suffer from this latter defect. The subjects are treated fully, particularly on the practical side, and the text is illustrated with a large number of well-chosen figures. E. W. R.

The Riddle of Religious Education and a New Solution

By Adam Gowans Whyte. (Thinker's Forum, No. 22.) Pp. 48. (London: Watts and Co., Ltd., 1942.) 6*d*. net.

IN the course of an article which appeared in NATURE of November 14 last, the position was maintained that the omission from the religious instruction of senior pupils of all reference to faiths other than the Christian would be hard to justify in these times. Mohammedans and Buddhists, Hindus and Parsees, Jews and other non-Christians, are fighting on our side in a war of good against evil—a struggle for a way of life which for many of us, but not for any of them, finds its historical expression in the New Testament. This position is very strongly maintained in Mr. A. G. Whyte's ably and vigorously written pamphlet. The body of the pamphlet is devoted to a brief historical review of all that has led up to the "dual system" of control. The writer makes some apposite quotations from eminent Churchmen who have been quite unhappy about the working of that system. His "new solution" goes all out for making religious instruction broader and more objective. He maintains that a fraction of the time spent during a child's school life in expounding the details of the Christian creeds would suffice to convey an intelligent appreciation of the fundamentals of other creeds, and to engender a more sympathetic attitude towards the millions who share our essential aims.

Annual Reports on the Progress of Chemistry for 1941

Vol. 38. Pp. xxxii+326. (London: Chemical Society, 1942.) 15*s*.

IT would be unprofitable to attempt to crystallize an already highly concentrated essence, and indeed all that is required is a reminder that these valuable reports continue to appear without interruption. Work on diamagnetism in recent years is summarized with special reference to its relation to problems of molecular structure, and developments in the chemistry of the carbonyls and nitrosyls since 1934 are surveyed. A comprehensive report on organic chemistry deals with physico-organic topics, organometallic compounds, polysaccharides, synthetic polyenes, polyterpenes, natural quinone pigments, and heterocyclic compounds. That on crystallography relates to temperature effects in the reflexion of X-rays from crystals, and to metal, inorganic, and organic structures. Among the biochemical subjects discussed are the vitamins, particularly their assay, since it is now recognized that definite minimal quantities are needed to prevent deficiency diseases, and larger quantities to prevent subclinical deficiencies. In view of war-time restriction on the importation of fruits, the incidence of vitamin C in raw and prepared green vegetables is of special interest. Another topic is the utilization of carbon dioxide by bacteria and animal tissues. Analytical methods are reviewed, and the book closes with a chapter on radioactivity and sub-atomic phenomena, in which a historical introduction is followed by a survey of present knowledge of nuclear processes and of the concepts used in explaining and predicting them.

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 26, 1941. Pp. 545. (London: Society of Chemical Industry, 1942.)

EXCEPT for an additional short section on starches, the chapters of this report correspond to those of the immediately preceding volume in the series. Vast as is the field surveyed, there can be no doubt that real progress is substantially greater, for much valuable information is necessarily being withheld from publication during the War. Many of the subjects discussed find emphasis, if not their origin, in the special demands of war-time needs; in this class are, for example, the manufacture of butadiene for synthetic rubber, substitute materials for ceramic products and the use of commoner in place of relatively rarer metals (as in the substitution of aluminium by zinc or tin-zinc alloy for milk-bottle caps). The section on plastics continues to reflect great interest and noteworthy progress, with an evermore complete fusion of "academic" and "technological" research. The supply of glycerin from soap manufacture can now be supplemented by its synthesis from propylene by way of allyl alcohol; and the physical properties of soaps and their solutions continue to attract much attention. In the section on sanitation and water purification there is reference to fluorosis arising from fluorine in drinking water: and there is quoted evidence that the incidence of goitre does not correspond to the iodine or the fluorine content of the water but may be of fungal origin. The year in review was marked by the pooling of research resources by five important drug manufacturers in Great Britain.

RESONANCE AND CHEMICAL REACTIVITY

By PROF. M. POLANYI
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OUR ideas on the mechanism of chemical reactions are still in flux, and the search for the most suitable conceptual framework continues. The following notes attempt a further slight shift in perspective, which seems to be well suited for surveying some of the more recent additions to this field of inquiry[1].

The nature of molecular structure has undergone in the last ten years a considerable degree of re-interpretation in the light of quantum-mechanical resonance. Wherever alternative bond assignments are possible—even though these may often seem of a rather remote and altogether speculative character—it now appears useful to take these into account and to represent the actual state of the molecule as resonating between all the component pure states.

We may extend this view by considering the initial and final states of a chemical reaction as alternative bond assignments of the same atomic system. In this sense, for example, $H_2 + I_2$ would be considered as one of the two pure states of which a system of 2H and 2I atoms is capable, the other pure state being represented by the alternative bond assignment HI + HI. Denote the eigen-functions characterizing the electron distribution in the pure initial and final states by ψ_i and ψ_f respectively, then the electronic distribution of the system is characterized in general by $\psi = \alpha_1\psi_i + \alpha_2\psi_f$. In these terms the chemical reaction signifies a continuous change of the coefficients α_1 and α_2, by which α_1/α_2, starting from very small initial values, achieves in the end values approaching infinity. The change can be seen to depend on the atomic co-ordinates. Take as an example the reaction

$$\underbrace{\mathrm{Na} + \mathrm{Cl}}_{x}\underbrace{{} - \mathrm{CH_3}}_{y(=y_0)} = \underbrace{\mathrm{Na} - \mathrm{Cl}}_{x(=x_0)} + \underbrace{\mathrm{CH_3}}_{y}$$

where y_0 signifies the normal bonding distance of C–Cl and x_0 the normal bonding distance of Na Cl. Initially $\alpha_1 \gg \alpha_2$ when x is large and $y = y_0$, whereas finally $\alpha_1 \ll \alpha_2$ when y is large and $x = x_0$.

We will suppose that—owing largely to the steric effects of the substituents attached to the central carbon—the reaction proceeds so that the distances x and y remain colinear, and making use of this simplified condition we will try to predict the activation energy of the reaction. Let E_i and E_f denote the energies of the pure initial and final states; and denote at the beginning of the reaction $E_i = E_i{}^0$, while at the end $E_f = E_f{}^0$. All the configurations of the atomic system which lie between these two stable configurations are necessarily unstable, and hence their energies lie higher than either $E_i{}^0$ or $E_f{}^0$.

Of particular interest among these unstable configurations are the 'transition states' in which $\alpha_1 = \alpha_2$, and for which the energies of the pure initial and pure final states coincide. The lowest of these is usually called '*the* transition state' or 'the activated complex' of the reaction, and the theory of chemical reactions consists mainly in attempts to predict the energy level of this state—by which the activation energy of the reaction is determined.

To obtain this level in our case, we introduce the further simplification that in the opening phase of the reaction the sodium atom can approach the chlorine atom to within the normal bonding distance x_0 without incurring appreciable repulsion. Hence we may imagine that the reaction starts with $x = x_0$, and that the x variable remains at this value throughout the reaction, while all the variations of the energy are determined by changes in y. In the pure initial state the variation of energy is seen to consist in the changes of the attraction energy (E_{iy}) of the chlorine-carbon bond; in the pure final state it lies in the changes of the repulsion energy (E_{fy}) arising between the chlorine and carbon atoms in the non-bonding state. Consequently we have $E_i = E_{iy}$ and $E_f = E_f{}^0 + E_{fy}$.

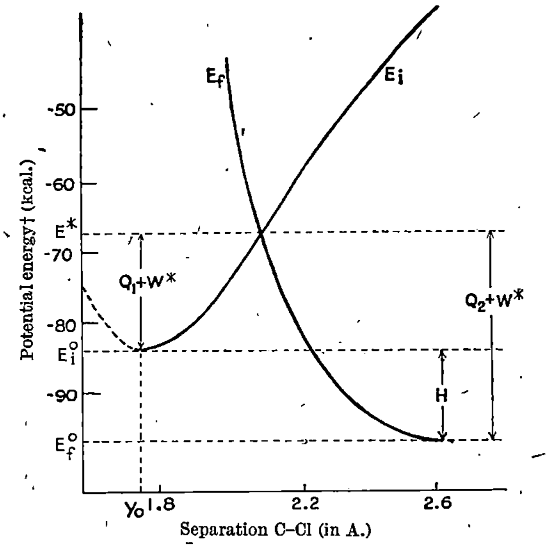

Fig. 1. MECHANISM OF REACTION
$\mathrm{Na} + \mathrm{Cl\,CH_3} = \mathrm{NaCl} + \mathrm{CH_3}$

E_i energy of extended C–Cl bond.
E_f energy of repulsion between H_3C and $Cl^-(Na^+)$ plus normal bond energy of NaCl.
y_0 normal bond distance C–Cl.
E_i^0 and E_f^0 energy before and after reaction.
E^* energy of transition state.
W^* resonance energy in transition state.
Q_1 and Q_2 activation energies of forward and back reactions.
H heat of reaction.
† Counted from level of free particles Na, Cl, CH_3.

By plotting both E_i and E_f as a function of y (Fig. 1) we find the point where their values coincide (E^*). This would represent the energy of the transition state, but for the fact that we have not yet taken into account the resonance energy which is bound to arise when a system of atoms can be represented by more than one bond assignment. This resonance energy will be negligible at the beginning and at the end of the reaction, and will reach high values only in the neighbourhood of the transition state. Therefore, if we define E^* as the energy at which levels of the pure states coincide, and call the resonance energy at the transition state W^*, then the activation energies Q_1 and Q_2 are defined by $Q_1 = E^* - E_i{}^0 - W^*$ and $Q_2 = E^* - E_f{}^0 - W^*$. Thus by determining E^* we can find $Q_1 + W^*$ and $Q_2 + W^*$, but not the values of Q_1 and Q_2 themselves.

However, in the case of Na + Cl CH_3 (and other 'ionogenic' reactions) it is possible to get a little further, without undertaking the difficult and uncertain calculation of W^*. An evaluation of the diagram in Fig. 1 for Na + Cl CH_3 yields $Q_1 + W^* =$

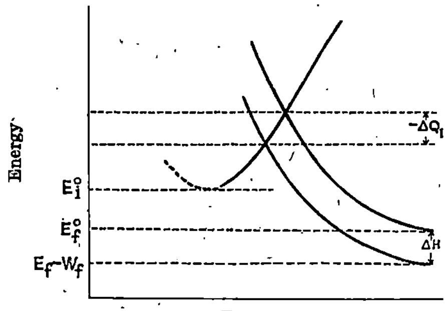

Fig. 2. CONNEXION BETWEEN CHANGES IN REACTION HEAT AND ACTIVATION ENERGY. ($\Delta H = W_f$ AND ΔQ_1 ASSUMED TO BE EQUAL TO ΔE^*).

16 kcal., whereas Q_1 observed[2] is 10 kcal. Thus W^* appears to be not excessively large, and we may well try to analyse the effect of replacing methyl by other radicals in the hope that the effects of such variations on W^* may be small or at least not entirely unpredictable. Take first a radical like allyl or benzyl, which resonates in the free state, whereas resonance is absent in the corresponding molecule. This causes a depression of the energy of the final state by the amount of the resonance energy W_f, the heat of reaction H being increased by $\Delta H = W_f$ (Fig. 2). The pure final state will be affected throughout in this sense and the E_{fy}-curve will be shifted bodily downwards—as shown in Fig. 2—by the amount W_f. The result is to depress the level E^* by $\Delta E^* = -\alpha W_f$, where α is a fraction depending on the angles of inclination at the crossing of the E_i and E_f curves. The value of α obtained from the diagram for our case is about 0·27.

We may add another relationship for the case that it is the R–Cl molecule which resonates whereas this time resonance is absent in the free radical. Vinyl chloride and chlorbenzene are compounds reliably assumed to be of this kind[3]. We may expect here a reduction of the heat to the extent $-\Delta H = W_i$ and also a corresponding elevation of the level E^* by $\Delta E^* = \alpha W_i$.

In this scheme W^* remains unaffected and the rate of reaction as determined by Q_1 should vary in a predictable way. There should be a decrease of Q_1 by $-\Delta Q_1 = \alpha W_f$ in the first instance and an increase $\Delta Q_1 = \alpha W_i$ in the second. Both cases would be covered by the relationship $\Delta Q_1 = -\alpha \Delta H$, which expresses a kind of revived Berthellot principle, connecting rates of reaction with heats of reaction (Fig. 2).

The conditions in which such a relationship can be postulated are clearly of a very special kind. They can be upset even for our chosen reaction—chosen for its particular simplicity—whenever there are present in the transition state additional bond assignments which do not appear either in the initial or the final state[4]. Suppose there is an oxygen atom present in ClR, as, for example, in $ClCH_2(CO)CH_3$. There is then the possibility that the Na + $ClCH_2(CO)CH_3$ transition complex will resonate with the alternative bond assignment $Na^+ + ClCH_2(C^{\cdot}–O^-)CH_3$. From this there will result an addition (W_1^*) to the resonance energy in the transition state and the activation energy will be reduced by an equal amount.

There is a further complication arising from the fact that in the free radical there is a lone electron which will tend to resonate in about the same way as the valence electron of sodium, causing, for example, in the radical $.CH_2(CO)CH_3$ the additional bond assignments $^+CH_2(\dot{C}–O^-)CH_3$ and $CH_2 = (C^+–\dot{O}^-)CH_3$. Hence there will be present also a certain amount of resonance energy (W_f) in the free radical, and the total depression of the activation energy will show the combined effect of W_1^* and W_f, so that $\Delta Q_1 = W_1^* + \alpha W_f$. Since we cannot calculate W_1^*, we can expect to ascertain this peculiar effect of the CO group (or of any other negative group having a similar function) only qualitatively by the existence of a ΔQ_1 that is distinctly larger than $-\alpha \Delta H$.

The experimental material which so far has been analysed in the sense of these ideas is collected in the accompanying table. A glance at the first column of figures shows that there is a distinct depression of the activation energy (as compared with $ClCH_3$) in a number of instances where an increased heat of reaction may be expected on account of resonance in the final state. Allyl-, benzyl- and acetonylchloride belong to this class. We also note that the two compounds, vinyl- and phenyl chloride, which react more slowly than methyl chloride, are both of the kind in which resonance would decrease the heat of reaction.

Radical (R)	Activation energy Na+Cl R (Q_1)	Substitution heat: RH+OH = ROH+H (Rossini[5])	First order constant of IR pyrolysis at 430° (k)	Activation energy of IR pyrolysis (Q_1')
vinyl	10·4		6	55
phenyl	10·4		14	54
methyl	10·0	16·0	14	54
ethyl	9·4	10·2	50	52
n-propyl	9·2	8·8	250	50
n-butyl	8·6	8·2	560	49
*iso*propyl	8·6		4000	46
t-butyl	7·8		9000	45
allyl	6·0		600000	39
acetyl	5·0		160	(51)
benzoyl	0		18000	44
acetonyl	2·0		9000	45
benzyl	2·9		23000	44

There is also a good deal of evidence favouring the assumption that the observed falling activation energies in the series methyl, ethyl, *n*-propyl, *n*-butyl, correspond to a parallel increase in the heat of reaction. In the second column of the table is a list of reaction heats, which show that the difference of the bond energies R–H and R–OH goes on decreasing all along the series. The only explanation for this effect seems to be the presence of a radical resonance of the type $CH_3 - CH_2^{\cdot} \longleftrightarrow H^{\cdot} \ldots CH_2 = CH_2$ which weakens both the R–H and the R–OH bond, but affects the latter to a much less extent[6,7]. Moreover, claims to have actually observed a fall in the bond energy of C–H by passing from CH_4 to C_2H_6 were quite recently made by D. P. Stevenson[8] and, independently, by Anderson, Kistiakovsky and Van Arstdalen[9], the values being given as $D(CH_3–H) = 101$ kcal. and $D(C_2H_5–H) = 96$ kcal. in the first and as $D(CH_3–H) = 102$ kcal. and $D(C_2H_5–H) = 98$ kcal. in the second instance.

Once a resonance of the type $CH_3 - CH_2^{\cdot} \longleftrightarrow H^{\cdot} \ldots CH_2 = CH_2$ is assumed to be effective, an even stronger effect of this kind must be taken to be present in secondary and tertiary radicals such as $(CH_3)_2CH^{\cdot}$ and $(CH_3)_3C^{\cdot}$. This would cause a marked fall in the heat of reaction in the series ethyl, *sec.*-propyl, *tert.*-butyl and make the observed fall in the activation energy in this series appear as a further qualitative corroboration of the above theory.

A further corroboration of at least an approximately quantitative kind can be based on observations of the pyrolysis of compounds in which chlorine is replaced by iodine. In a series of experiments made during 1938–40 and now in the course of publication, E. T. Butler and I observed very wide variations in the rates of pyrolysis of different iodides[12]. The observed rates extrapolated to a common temperature 430° C.—listed in the table—vary in a sense largely parallel to the rate of the sodium vapour reactions of the corresponding chlorides. The experimental conditions of the pyrolysis were such that the rate was likely to be governed primarily by the monomolecular dissociation of the C–I bond. If that is so, then $Q'_1 = (13 \log k)RT$ should correspond approximately to the energy of that bond. This assumption is supported by the fact that the Q'_1-values calculated for methyl iodide and ethyl iodide from this relationship closely correspond to the C–H bond energies mentioned above[10] and established quite independently after the preliminary publication[11] of our results. The table shows further a reasonable measure of agreement with such variations in bond-energy as may be expected to occur from considerations of resonance. On these grounds we felt justified in attempting a verification of the relationship $\Delta Q_1 = -\alpha \Delta H$ by setting $\Delta H = \Delta Q'_1$ (Fig. 3).

It is clear that for the compounds listed in the figure a marked parallelism exists between activation energy and the postulated variation of reaction heat. It is also clear that the proportionality factor α is—as the theory requires it to be—a fractional magnitude, somewhat less than one half. It so happens that the straight line in Fig. 3 drawn by the method of least squares defines a factor $\alpha = 0{\cdot}28$ which actually agrees closely with the value derived for α from Fig. 2; but this precise correspondence must be regarded as a mere coincidence.

Fig. 3 does not contain the three oxygen-containing compounds acetyl-, acetonyl- and benzoyl chloride, nor does it contain benzyl chloride. In all these cases the activation energies are much lower than the relationship $\Delta Q_1 = -\alpha \Delta H$ would lead one to expect, and the values fall altogether out of the picture. This is exactly what we predicted above for the oxygen-containing compounds, for which an extra resonance in the transition state was postulated. It would seem that the C_6H_5 group exercises a similar influence to oxygen, though in this case the mechanism is still obscure.

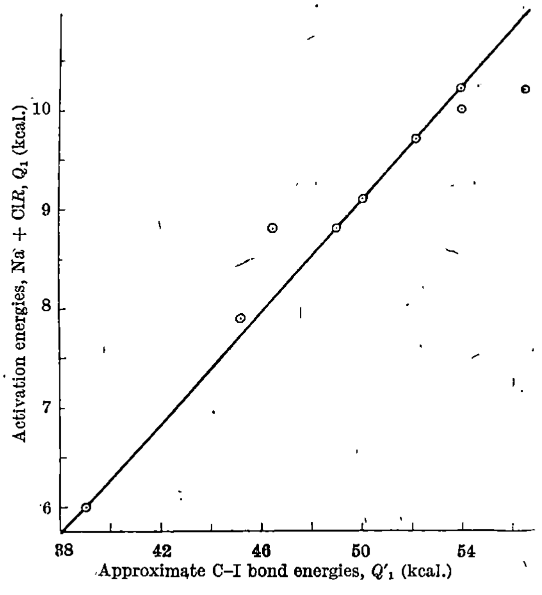

Fig. 3.

It seems reasonable to hope that when this kind of investigation can once more be resumed, further parallel observations on the rates of the sodium vapour reaction of halides and of the rates of their pyrolysis (compared also with the rates of some corresponding reactions in solution) may be found to disclose clearly the main factors which determine the effect of chemical substitution on reactivity. The theory—with all its present weaknesses—seems to have allowed us to recognize the type of reactions in which the simplest conditions are likely to prevail, as well as the factors that have to be considered in the first place when analysing the results.

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[1] Systematic speculations on the mechanism of chemical reactions were first started by F. London (1928) and by H. Eyring and M. Polanyi (1931). The simplified theory of 'ionogenic reactions' used in the text was first suggested by Ogg and Polanyi (*Trans. Far. Soc.*, 31, 607; 1935) and later elaborated by M. G. Evans and Polanyi (*Trans. Far. Soc.*, 34, 11; 1938).

[2] Compare Evans, M. G., and Warhurst, E., *Trans. Far. Soc.*, **35** 593 (1939).

[3] Brockway, L. O., Beach, J. V., and Pauling, L., *J. Amer. Chem. Soc.*, **57**, 2693 (1935).

[4] Such a possibility was first considered by M. G. Evans and E. Warhurst for the case of the diene-synthesis (*Trans. Far. Soc.*, **34**, 614; 1938) then applied to the present problem by M. G. Evans and M. Polanyi (NATURE, **148**, 436; 1941).

[5] Rossini, F. D., *Bull. Bur. Standards J. Research*, **13**, 29, 189 (1934). Knowlton, J. W., and Rossini, F. D., *ibid.*, **22**, 115 (1939).

[6] Wheland, G. W., *J. Chem. Phys.*, **2**, 474 (1934).

[7] Baughan, E. C., Evans, M. G., and Polanyi, M., *Trans. Far. Soc.*, **37**, 377 (1941).

[8] *J. Chem. Phys.*, **10**, 291 (1942).

[9] *J. Chem. Phys.*, **10**, 305 (1942).

[10] Compare Baughan, E. C., and Polanyi, M., NATURE, **146**, 685 (1940).

[11] Butler, E. T., and Polanyi, M., NATURE, **146**, 121 (1940).

[12] *Trans. Far. Soc.*, **39** (1943).

SOME EARLY CZECH CONTRIBUTIONS TO BOTANY

By DR. GERALD DRUCE

IN Bohemia the science of botany began, as elsewhere, through its applications in medicine and agriculture. A consideration of the uses of plants led to the first Czech writings on the subject before there was any idea of a study of plants for their own sake. Herbals, containing descriptions of local plants, began to appear in the fourteenth century and were more or less elaborately illustrated. Probably the earliest in Bohemia was the "Lekarszké Knizky" or "Erbarius", of Christian of Prachatice, who was a *Magister* of the University of Prague, where he taught between 1392 and 1435. It listed 156 plants, and this was first printed from the original manuscript in the sixteenth century[1].

Of more importance was the "Kniha lekarzská kteraz slowe Herbarz, aneb Zelinarz" of Jan Černý (1480–1530). It was first printed at Nuremberg in 1517, then at Prague in 1544 and 1554, and at Olomouc in 1554, and was illustrated with woodcuts and had considerable importance, as its many editions indicate. It was, in fact, more than a herbal since it contained accounts of minerals and inorganic substances then used in medicine, for Černý was primarily a medical man interested in plant products.

Other early Czech herbalists include P. A. Matthiolus, who also wrote a commentary on Dioscorides

(1554), and the medical man, Thaddaeus Hájek (1525–1600), who translated Matthiolus's Latin work into Czech and produced an original "Herbarz ginak Bilinarz" (Prague, 1562).

The first Czech to claim to be a botanist pure and simple was Adam Zalužanský, born at Mnichovohradiště in 1558, who died of the plague in 1613. He was the first writer to advocate a study of plants as a separate science. In his "Methodi Herbariæ" he wrote: "It is usual to connect medicine with botany, yet scientific treatment demands that we should consider them separately. For in every science the theory must be dissociated from practice and the two must be dealt with separately in their proper order before they can be united. Botany (which is, as it were, a special branch of physics) should form a unit by itself before it can be brought into connexion with other sciences." Zalužanský was a remarkable man. He graduated at Prague in 1581 and after some years of travel returned to lecture on natural philosophy. He was elected rector of the University in 1593 and attempted to re-organize the curriculum as well as introduce complete religious freedom and secularize the University. He wanted especially to advance and broaden the teaching of science. His work, "Rzad Apothekarzský" (1592), set forth the scope and aims of pharmacy and the duties of apothecaries towards the community. As a botanist he has been compared with Cæsalpino, and though his herbal was not in advance of contemporary publications as regards the number of specimens described, it was unique in giving a comprehensive survey of botany as a distinct subject. In his classification he began with fungi as the lowest (known) organisms, passing to mosses, then ferns, grasses, other flowering herbs, and concluding with trees. He endeavoured to pass from simpler to more complex types and evidently regarded lower cryptogams as primitive types. Considerable importance was attached to leaf appearance, and this led him to class umbellifers and even some of the composites with the ferns.

The contemporaries of Zalužanský included Jacob Hořčický (1575–1622), keeper of the gardens of Rudolf II and Jan Jesenský, or Jesenius (1566–1621), a Silesian Czech naturalist and medical man who became rector of the University of Prague and was among the anti-Hapsburg intellectuals executed in 1621. Hořčický, or Sinapius, was court apothecary and specialized in the cultivation of herbs which he distilled in steam (according to a method probably acquired from Černý's herbal) to yield aromatic "waters" which are credited with curing Rudolf from an acute attack of gout so that the emperor ennobled him with the title, *von Tepenec*.

Zalužanský died just before the disturbing times of the Thirty Years' War and its persecution of the Czech people. All progress in science was checked for a hundred years. Except for occasional references to botany and other sciences scattered through theological writings, no attempt was made to impart any scientific knowledge in the schools or at the University. One such reference is that of Marcus Marci in "Idearum operaticum idea" (1667), where an account is given of "metamorphosis" in plants. Importance out of all proportion to its scientific merit, therefore, is attached to the collection of plants made by the priest, J. F. Bečkovský (1658–1725). It contained about two hundred specimens, but Bečkovský was an amateur rather than a serious botanist and knew only the herbal of Matthiolus. He confused many different plants and frequently assigned wrong names to his specimens.

In 1662 the University of Prague received new statutes. One of these provided for five professors in the medical faculty, including one for botany. The curriculum was to include a study of medicinal plants, to be undertaken in the summer of the first year of study, and in the third and fourth years instruction was to be given in the preparation of plant medicines. Science, however, did not flourish, and in 1688 the faculty had only three professors and four unpaid assistants. What lectures there were in botany were given by the professor of anatomy and surgery. Between 1649 and 1740 thirteen lecturers in botany were appointed and not one made the subject his first interest. Two of them, J. J. V. Dobřenský (1632–97) and J. A. Scrinzi (1697–1773), are worthy of some consideration. Dobřenský was a medical man who had studied in Modena and Ferrara. He knew more chemistry than botany though he taught both and wrote about a dozen Latin works on natural science and medicine. Scrinzi was the first occupant of the chair of chemistry and physics at Prague. He practised medicine at Mladá Boleslav, about thirty miles north-east of Prague. It was Scrinzi who demonstrated the evacuated 'Magdeburg hemispheres' before Maria Theresa in 1754, using two teams of horses that failed to draw them apart.

In 1755 K. Sagner (1721–81) was lecturer in botany and printed for his students a work entitled "Institutiones Philosophicæ", which contained a general account of botany, including a carefully arranged section of plant physiology as then understood. He was one of those appointed as a result of the changes introduced during Maria Theresa's reign (1740–80) through the insistence of her physician, Gerhard van Swieten. The first professor of botany and materia medica was a Dr. Scotti, who planned a physic garden in 1752 and by which he is remembered. His successor was a Czech, Jan Bohadsch, or Bohač (1724–68), whose lectures had to cover the whole field of natural science. He made excursions all over Bohemia to collect material for a monograph, "Flora, fauna et historia lapidei Bohemiæ", which remained, however, in manuscript. After his death during an excursion in west Bohemia there was no professor in natural history until 1775, when his pupil, J. J. Zauschner (1737–99), was appointed. Zauschner made various contributions to the advancement of botany in Bohemia, including the re-discovery of *Gagea (Ornithogalum) bohemica*[2] mentioned by Černý, but afterwards overlooked. At this time it became possible to announce discoveries and to describe unusual plants and other scientific phenomena, since in 1770 there was formed a society for the advancement of science. It was at first styled the *Privatgesellschaft* (*Učená Společnost*, or 'learned society'), but in 1784 adopted the more expressive title of Royal Bohemian Scientific Society (Kralovská Česká Společnost Nauk). Among the original members were Bohač, Zauschner and another botanist, Jan Mayer, and it had several patrons among the nobility. In 1774 the Society offered prizes for work in science, and these were awarded to K. Sandberg of Brno and A. Voigt of Vienna. Sandberg's essay directed attention to the absence of an adequate Flora of Bohemia, and this prompted botanical excursions to various parts of the country, particularly to the Giant's Mountains. The Society published the results of these expeditions in a series of essays which gave an impetus to the study of plant life. Notable among them were the observations of Thaddæus Haenke (1761–1817). His detailed work on the flora of north Bohemia brought him into prominence and led to his famous expedition to South America under the patronage of Count Sternberg. The masses of material he dispatched to Prague were later the subject of a handsome work in two volumes known as the "Reliqueæ Haenkeanæ", in the production of which the best Bohemian botanists collaborated.

The first attempt at a complete Flora of the country was that of F. W. Schmidt ("Flora Boemica"), which appeared in 1793–94. It was, however, uncritical and included plants that the author guessed would be found in naturally rich areas like the Giant's Mountains and the Bohemian Forest. A second attempt was made by Prof. Jan Novodvorský (1773–1810), but his manuscript was burnt just before he died. A third work, by J. E. Pohl (1782–1834), was also fated to remain unfinished, though two parts of his "Tentamen Flora Boemiæ" did appear in 1817. Pohl's flora was based on his own observations and on those of others which could be verified by visits to the localities where the plants grew.

Far superior was the "Flora Čechica" of the brothers J. S. and K. B. Presl. It had been completed in 1812, but was not printed until 1819. The preface was in Latin and was followed by a section in Czech, *Napomenutí* (reminders), in which the authors explained how they revived Czech botanical terms and also introduced new ones where needed by adapting Polish or Russian expressions to bring the subject into line with the Linnean system, which they followed in compiling the Flora. J. S. Presl, who did so much to advance the study of science among the Czech people, whereas his brother was more occupied in original investigations, particularly in connexion with the study of ferns, wrote a general text-book of botany ("Rostlinář", 1822), which included introductory biology, plant chemistry, besides anatomy, plant physiology and what would now be styled ecology. The illustrations were remarkably faithful, and some copies were hand-painted by his sister. It served as the basis for later Czech botanical treatises, and most of the terms used for flowering plants are still applied to-day, but those relating to cryptogams have largely disappeared or undergone alteration.

In addition J. S. Presl wrote an elementary botany and also an advanced work, "Všeobecný Rostlinopis" (general botany) in two volumes of more than two thousand pages. It appeared in 1846, and four thousand copies were circulated, a remarkable tribute to the interest in botany shown by a small nation in the middle of last century. K. B. Presl's work reached a more international public since he wrote mostly in Latin. Fourteen of his papers are listed in the Royal Society's catalogue of scientific papers. His books include a classic on ferns, "Testamen Pterodographiæ" (1836), with beautifully executed plates, many of the species being described for the first time. It classified 117 genera, and a supplement in 1845 brought the total to 132. This was his greatest work, though he also wrote a monograph on lobelias[3].

Several nobles, who were landowners in Bohemia, also encouraged the development of science. Thus, Count Malabaila Canal (1745–1826) was interested in applied science, cultivated a garden of economic plants and founded a lectureship in applied botany, the last lecturer being K. B. Presl. He encouraged the growing of sugar beet and established the first Czech factory for its extraction. He also improved fruit cultivation by introducing better grafting methods. Count Berchtold encouraged the cultivation of more potatoes, patronized contemporary botanists, and was a generous supporter of the National Museum. He wrote a standard work on the potato, and also a book on economic plants[4]. But the greatest botanist among the Bohemian nobles was Count Kaspar Sternberg (1761–1838), who not only supported contemporary Czech men of science but also was himself an investigator and author of considerable merit[5]. Most of his seventy-four works were in German, though he refers to Czech as "our tongue" and he translated some Czech mining notes into German in his paleobotanical treatise, "Flora der Vorwelt". He was instrumental in founding the Bohemian National Museum in 1818, became its first president, and gave it his herbarium of 9,000 specimens, to which he added purchases from abroad and the collections sent by Czech botanists from overseas. Sternberg also appointed Palacký, the historian, to be editor of the Museum's quarterly journal, and this has since been a powerful propagator of science among the Czech nation up to the present time. His last public function was to preside over a congress of medical men and naturalists at Prague, and he took great pride in announcing the recent discoveries of Purkyně, the Presls and others, to show that the Czech nation was making its contribution to the advancement of science whatever might be the truth of Liebig's recent assertions concerning the low level of science in Austria[6].

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[1] The works mentioned in this article were consulted at libraries of the Czech National Museum, the Charles University and other institutes in Prague, and at Brno and Litomyšl in Czechoslovakia. Some works were read at the British Museum and at the library of the London School of Slavonic Studies.

[2] Much information relating to the development of botany in Czechoslovakia is contained in "Vývoj české Přírodovědy" (Development of Czech Natural Sciences) edited by the late Dr. L. Viniklář, 1932).

[3] K. B. Presl's name is attached to seven species of ferns native to Britain according to G. C. Druce's "Pocket Handbook to British Plants". Riley's "Catalogue of Ferns" (London, 1841) contained "additions by C. B. Presl".

[4] Berchtold, "Die Kartoffeln" (Prague, 1842).

[5] NATURE, **139**, 1028 (1938).

[6] *Liebig's Annalen*, **25**, 339 (1838).

WAR-TIME NURSERY SCHOOLS

By Mrs. F. A. OGDEN

SCHOOL nurseries are not by any means new ventures even in Great Britain, but war-time conditions are responsible for their immediate expansion and improvement. Nursery schools for the care of the 2–5 year old children were established by local authorities in many parts of England during the 1914–18 period and afterwards, but in very few cases was there accommodation adequate to the growing needs. Schools were started in an experimental sort of way, and the permissive attitude of the Board of Education seemed to encourage the lull in progress. It would have been fortunate for the country if every local education authority had been in control of sufficient nursery schools to cope with all the 2–5 year old children in 1939. When war broke out and the call for women in industry became accentuated, so the need for proper accommodation for their young families made itself felt, and war-time nurseries were speedily developed. In some centres new nursery schools were prepared or completed. In many, nursery classes were established in the junior schools and these brought a new low age-level of infant classes where, in difficult circumstances, children under two years of age were admitted. In more isolated places day nurseries were set up by voluntary bodies and these experiments certainly played a part in urging accommodation to meet the new needs. To release young mothers for essential war production, residential nurseries for children of less than two years of age became necessary, and maternity and child welfare committees of local authorities acting under the Ministry of Health made rapid progress in providing suitable accommodation. Grants to local authorities for establishment and maintenance by the Government were very generous, and the needs of the population of working mothers in most industrial areas was in some measure supplied. In the years 1937 and 1938 immediately preceding the War there were 107 nursery schools in Great Britain, registering an average attendance of 8,274 children less than five years of age. Thus it will be seen that a very small proportion of the population was then accommodated. In addition to further schools of this type in 1942, there were more than 1,000 day nurseries, 400 residential nurseries and 500 more in course of preparation. Nurseries of to-day can be grouped under the following heads:

(1) Nursery schools (under the authority of the local education committee and the Board of Education), day only;

(2) War-time nursery classes (under the authority of the local education committee and the Board of Education), day only;

(3) Residential war nurseries (under the authority of the Maternity and Child Welfare Committee and Ministry of Health), 24 hours or 6 days.

(4) Voluntary nurseries controlled by other voluntary organizations, such as the Women's Voluntary Service, Canadian Red Cross, British Red Cross, Anglo-American War Relief Fund, etc.

In day-nursery classes difficulties arising from war conditions, such as hours of work of parents on night shifts, etc., had to be met, and it became necessary to revise the hours of attendance of teaching staff in the junior schools affected. It would be impossible to pay too high a tribute to the young teachers who took voluntary duty at 6 a.m. or stayed until 8 p.m. to meet the convenience of war working mothers. Difficulties in providing equipment were met by the combined efforts of amateur craftsmen in A.R.P. posts, schoolboys in woodworking classes, W.V.S. sewing and knitting parties—and bright toys soon changed the school atmosphere and produced a delightful nursery air. Stencilled friezes of wonderful design in gay colours shut out the heavy tones of a dreary outside world; inviting rest hammocks with cosy rugs appeared; accommodation for personal hygiene was provided or multiplied; miniature towels, toothbrushes and bright pinafores made their appearance; in other rooms dainty tables and small chairs with crockery and gaily coloured cloths were installed.

The ideal nursery school is a place of great delight. The tiny children arrive in charge of mother, father or elder one of the family at 6 a.m. or 8 a.m. A young teacher with the right feminine instincts normally takes over. With quick observation she registers tired or rested, sick or well, washed or unwashed; outdoor clothes are divested, hands and face washed, personal attention given if needed, and the child is soon absorbed in the inviting atmosphere, losing his self-interest and forgetting his little worries. Later, tables are prepared for breakfast and four little people take their chair to a table, where after a simple grace they are soon enjoying their first meal of the day—a well-balanced, healthful breakfast.

Self-education is a great feature of the nursery training to-day. Careful direction is given, but the temptation to which mothers so often yield to 'do for' and to 'show how' is advisedly resisted. It is not unusual to see a child of three years working with a small hammer and a few nails and, without any outside help, producing a simple toy roughly put together but with a clear indication of achievement which is easily recognized; it is to the child-mind a real boat or ship complete with mast, or a bomber plane fitted with bomb racks (this is a record of actual observation). Perfection in execution is a far step, but the self-conceived idea, the attempted expression and satisfaction in completion are valuable apperceptive links for the child and valuable guide lines for the teacher. Primitive dolls in cradles or beds, gardens and hen coops indicate other lines of interest, while on one occasion a child revealed that its chief delight was in producing coffins with tiny bodies rolled out in plasticine lying therein. When the play period is ended, the morning milk, cod liver oil or fruit juice is given, according to nurse's directions, to each child, and a period of restful attention to teacher's talk provides a physical relaxation as a counterpart to the engagement of the mental faculties. Time for lunch soon arrives and training in personal hygiene precedes the meal. The older children of four and five years are very quickly trained to help in serving and assisting the younger members of the community, showing good examples in table manners to the less advanced. The lunch is balanced on dietetic principles by the medical officer and his staff, cooked by a trained woman, and is designed to give all the nourishment required at the proper age. After the lunch, while the children have a period of free play, with toys indoors, or in the sunshine out of doors, the rest hammocks are disposed on the floor and tired little heads and hands are soon resting on them. Even here the teacher's watchful eye must be on the alert. Restlessness must be carefully noted and investigations made which may result in the temporary attention of the teacher or in the calling of a nurse or even a doctor. Much can be learned of a child's temperament and condition by a careful observation of its resting period.

Observation of the child's play interest and activities is a most valuable index to the understanding teacher of his moral and mental tendencies and his growing character. Stimulation or discouragement at the right moment may help to attain the proper balance which results in a normal social attitude.

The importance of early training in regular personal habits cannot be over-estimated. The instincts of the primitive peoples are sometimes reflected in child behaviour. The wolfing of food at irregular times, attacks on weaker children which seem sometimes to have no object but subjugation, the acquisition of coveted toys by force, the destructive craze, or the satisfaction resulting from obvious discomfort in others, are examples of under-developed and uneducated reaction. Careful training in proper behaviour and regular habits with a view to the comfort and happiness of the community is an aim of nursery school life. Self-control is induced by insisting on the proper time for personal hygiene. This may have far-reaching consequences and provide a sound basis for character formation which will react to the individual and communal benefit in later years. From the point of view of physical health, conditions in war-time nurseries are more propitious to sound development than those in 90 per cent of the homes from which the children are drawn. The balanced diet; the opportunity for fresh air and play; regulated sleep; the use of educational toys; the advantage of communal interests and choice of companionship; the opportunity for free expression in the choice of toys are all advantages which could not be supplied in the great majority of the homes from which the children have come.

The teacher who is suitable for nursery school work has special qualifications natural to her character. With a good educational background she develops the capacity to make herself understood by small children. Her voice is gentle and clear. If she has imagination she can make the nursery stories live so that they will remain as an influence with the young minds long after school days. The ability to draw, with a good sense of colour, to play simple nursery songs and to sing lullabies is a very desirable addition to her qualifications. Above all, she should be healthy with a developing maternal instinct of her own, finding its early expression in a communal way and giving sympathetic understanding and love to the children under her care. In the last two years there has been great competition to enter colleges for nursery school work, and this should have made it possible for the most suitable young people to be selected. It is therefore a well-founded hope that future years will provide a sufficient staff of the right quality for the nursery schools which we hope to see in abundance in a post-war period. At the moment the teaching staff of war-time nurseries is deplorably inadequate. A considerable proportion of it consists of young girls leaving school at the age of fourteen who with a short course of six weeks training have loyally undertaken the responsibility. A large proportion also consists of older mothers whose families are grown up and who may have had little contact with young life in the last twenty-five years. Nevertheless they too have loyally placed their service at the call of the country's need, and the valuable maternal instinct which has been the foundation of a short course of training lasting 4–6 weeks has of necessity had to be their only training for this very responsible and important work.

Records of progress show that physically and mentally the children in these schools have received great benefit, and the contribution to the stamina and resource of the nation cannot be properly assessed at this juncture. It may be, however, that out of this war-time experience will grow a permanent and complete scheme for the proper care of young life.

OBITUARIES

Prof. F. D. Adams, F.R.S.

FRANK DAWSON ADAMS, emeritus Logan professor of geology and vice-principal of McGill University, Montreal, died on December 27 at the age of eighty-three. He was one of the great pioneers in the study of the Precambrian rocks of Canada and in the field of experimental geology. Born in Montreal on September 17, 1859, Adams was educated at McGill University, where he came under the influence of Sir William Dawson, his great predecessor in the Logan chair. After a year of postgraduate study at Yale, he was appointed an assistant on the Geological Survey of Canada: in this service he continued until 1889, when he resigned to become lecturer in geology at McGill University, succeeding to the chair four years later.

Adams's first field investigations were devoted to a study of the character and relations of the large anorthosite bodies lying near the border of the Canadian Shield, north of the St. Lawrence River, within and close to Logan's original Laurentian area. This group of rocks, in places exhibiting a distinct foliation, was supposed by Logan to form a stratified series—his Upper Laurentian—distinct from, and reposing on the Grenville Series. Adams at this time was well equipped for his task—he was a skilled petrographer versed in the new methods of the science, for he had already studied under Rosenbusch—and the detailed mapping he began in 1883 soon brought results of the first importance. He conclusively demonstrated the igneous nature of the partly foliated anorthosites, revealed the aqueous origin of an important group of highly metamorphic garnet gneisses within the Grenville Series and was thus led to a fundamental revision of the classification of the Precambrian in the St. Lawrence area. Some of these results were published as a dissertation at Heidelberg, where he had continued his researches under Rosenbusch during several summer semesters.

Meantime, the epoch-making investigations of A. C. Lawson on the Laurentian succession in the Lake Superior region 800 miles westward had been published, and led Adams, on the completion of his researches in Quebec, to a detailed survey of a large area of the Grenville Series in Eastern Ontario in order to provide a satisfactory knowledge of the Precambrian succession in Eastern Canada. The region selected—the Haliburton-Bancroft area—was geologically almost a *terra incognita*, of which no topographic survey had been made. The field work, in which he was later joined by A. E. Barlow, occupied eight years, the results being published in a memoir in 1910.

These investigations form a classic study on the Canadian Shield and placed Adams in the front rank of petrologists. The phases of metamorphism and varied constitution of the underlying Grenville Series and the character and relations of the succeeding Laurentian granite 'batholiths' were brilliantly demonstrated, while the beautiful maps which accompanied the memoir have furnished the type material for all later discussions on concordant intrusives in folded sediments. Among the more striking petrographic results was the discovery of great bodies of nepheline syenite about the borders of the Laurentian granites. These alkali rocks presented many remarkable variations in composition, and some varieties, being rich in corundum, were afterwards made the basis of an extensive industry for the exploitation of this mineral.

Adams's ripe experience and acknowledged authority in the field of Precambrian research led to his appointment to several international committees to investigate critical localities and to report on the correlation and nomenclature to be adopted for the Precambrian areas on both sides of the Canadian boundary.

The second great field of endeavour in Adams's career was his study of the experimental behaviour of rocks under differential stress. His keen interest in this department of research was engaged by his long and close observation of the foliated and gneissic rocks of the terrains he had mapped and by the realization that light on this subject might be revealed by experiment in which the factors of pressure, temperature and solution were separated, and the part played by each investigated, first independently, and then in combination. In this work he had the great advantage of collaboration with his engineering colleagues at McGill, first of Nicolson, later of Coker, while his financial resources were supplemented by a grant from the Carnegie Institution. Their results are set down in a remarkable series of publications dealing with the experimental flow of rocks (1901), the elastic constants of rocks (1906), the flow of marble (1910) and an experimental investigation on the depth of the zone of flow in the earth's crust (1912, 1917).

Formerly, almost the only quantitative data on the mechanical behaviour of rocks had been obtained by crushing cubes of rock in a testing machine according to the ordinary rules of engineering practice. Adams's experiments clearly demonstrated that rocks change their character when a confining pressure is applied so that they are no longer brittle but behave plastically. He was able to show that the structures presented by the deformed rocks matched some of those seen among crystalline schists, that the plastic flow of marble in his experiments was associated with gliding or twinning of calcite, unaccompanied, even at the elevated temperatures used or in the presence of water, by re-crystallization, and that in order to develop flow within the crust a rock must be subjected to differential stress which is much, often many times, greater than that sufficient to crush it under ordinary conditions obtaining at the surface.

These experiments had a direct bearing on various problems presented in geophysics—among them the movement of nappes and isostasy—and they have been the first to supply the much needed quantitative data for the study of these and related problems. As such they have formed the pioneer researches in this field of experimental geology, and it is only within recent years that investigation on these lines has been renewed under more closely controlled experimental conditions which advance in technique has permitted.

After his retirement from the Logan chair at McGill, Adams's activities continued unabated. He visited the Far East and spent several field seasons in Burma, Malaya and Ceylon. The most important of his publications during this period was his "Geology of Ceylon" (1929), which presented the first geological map of the island and the first attempt at deciphering its larger structures.

Adams's keen interest in the history of his own chosen field of geology was evinced in many of his early writings. Through the years by diligent search he had gradually acquired a great collection of rare historical texts, and their study served greatly to enrich the scholarly memoir on the "Birth and Development of the Geological Sciences" (1938) which formed the final product of his labours.

During a long and distinguished career, Adams received many honours both in Britain and America. His frequent visits to Great Britain had brought him into close contact with the leading British geologists, and he was a well-known figure at scientific congresses. He was elected a fellow of the Royal Society in 1907 and he was a foreign associate of the U.S. National Academy of Sciences; he served as president of the Geological Society of America (1918), and as the outstanding Canadian geologist of the time was chosen as president of the International Geological Congress which met in Canada in 1913.

C. E. Tilley.

Mr. F. W. Harbord, C.B.E.

Mr. Frank William Harbord, who died on December 27, at the age of eighty-two, after a long and active career as a metallurgist, was born in Norwich and studied at the Royal School of Mines. After holding posts in iron and steel works in Staffordshire he became consulting metallurgist to the Indian Government, and from 1892 until 1905 he was at the Royal Indian Engineering College at Coopers Hill. In 1905 he took up private consulting practice in London, and the firm of Riley and Harbord (later Riley, Harbord and Law) has always enjoyed a high reputation in the metallurgical world. Although greatly hampered in later years by failing eyesight, he retained his position as senior partner until his death.

Harbord published very few original papers, but he contributed regularly and usefully to the discussions before the Iron and Steel Institute, and his text-book on the "Metallurgy of Steel", in which Mr. John Hall collaborated on the engineering side, reached a seventh edition and long retained its position as the standard English authority on the subject. In his earlier career he published papers on the removal of non-metallic elements from steel in the basic open-hearth process, on nitrogen and arsenic in steel, and on the relations between the properties of steel and its process of manufacture. In 1937 he reviewed very fully the history of the basic Bessemer process, drawing largely on his knowledge of the men connected with its development. The problem of the efficiency of steel works was discussed by him on several occasions.

He was closely associated as a consultant with the development of many new inventions, and in 1903, at the request of the Canadian Government, he reported on the position of electric smelting processes. During the War of 1914–18 he rendered valuable services as honorary metallurgist to the Ministry of Munitions, and at its end was awarded the C.B.E. He was also an officer of the French Legion of Honour.

Harbord took an active interest over many years in the work of the Iron and Steel Institute, being a regular attendant at its Council and committee meetings. He received the Bessemer Medal of the Institute in 1916. His kindly character made him a very popular member.

C. H. Desch.

We regret to announce the following deaths:

Dr. George Crile, director of research at the Cleveland Clinic Hospital, of which he was one of the founders, and an honorary fellow of the Royal College of Surgeons, who was known for his work on surgical shock, on January 6, aged seventy-eight.

Sir Arbuthnot Lane, Bt., C.B., the well-known surgeon, on January 16, aged eighty-six.

Sir Henry Maybury, G.B.E., K.C.M.G., C.B., president in 1933 of the Institution of Civil Engineers, on January 7, aged seventy-eight years.

NEWS and VIEWS

Lister Institute of Preventive Medicine

Sir John Ledingham, C.M.G., F.R.S.

Sir John Ledingham, who will retire from the directorship of the Lister Institute of Preventive Medicine at the end of next March, has served the Institute for thirty-seven years, during which he has come to occupy a leading place in bacteriological studies. His wide and detailed knowledge of the literature of bacteriology and immunity and his personal participation and intimate association with many aspects of related research led to his large share in the initiation and production of the Medical Research Council's "System of Bacteriology" in nine volumes (1928–31), which aimed at presenting the British view of the subject. By installing at the Lister Institute the M.R.C. National Collection of Type Cultures, which before the War distributed 5,000–6,000 cultures to all parts of the world annually, and by acting as its director, he greatly furthered the study of bacteriology. In 1907 he began an extensive investigation of carriers of *B. typhosus*, and work on carriers of diphtheria and dysentery bacilli and of the meningococcus was also undertaken in the Department. As the result of detailed studies from 1924 onwards of the skin reaction to intra-dermal inoculation of vaccinia virus, Sir John showed that the elementary bodies described by Paschen in 1906, but afterwards rejected by most bacteriologists, were indeed the pathogenic virus, and were derived from the intracellular inclusions (Guarnieri bodies). Sir John was able to concentrate and purify the virus by centrifuging and to obtain an agglutinating serum for the elementary bodies. In his Harben Lectures (1925), he summarized his work and the then known facts concerning natural immunity, the carrier problem and the variola group of diseases.

In 1932, Sir John Ledingham turned his attention to the causal agent of pleuro-pneumonia of cattle and pointed out that this so-called virus was quite unlike the true viruses, such as those of vaccinia and foot-and-mouth disease, etc. Although filterable in certain stages, its growth on culture media and its varied forms showed that it belonged to a special group, of which the microbe of Agalactia of sheep and the symbiont occurring in cultures of *Streptobacillus moniliformis* were members, as well as certain pathogens from the lungs of rats and some saprophytic forms found in sewage. During Sir John's directorship, the Serum Department at Elstree and the Biochemical Department in co-operation have devoted much time to the selection and purification of bacteriological antigens for use as prophylactic vaccines and for the immunization of horses, and considerable improvements have resulted, especially in dealing with sporing anaerobes, the meningococcus and *B. typhosus*.

In 1935 a Department of Biophysics was opened at Chelsea and a high-speed centrifuge reaching 60,000 r.p.m., an equilibrium centrifuge and an electrophoresis apparatus, all designed by Prof. The Svedberg, were equipped by the generosity of the Rockefeller Foundation. By these means the constituent factors of sera and other mixtures of proteins have been separated and examined and the elementary bodies of several viruses concentrated and purified. Other physical problems connected with the freezing and drying of these substances have also been attacked. Among other lines of research in which Sir John and the bacteriological staff have been specially interested have been phagocytosis, tularæmia, the diffusion factor in wounds, and the connexion between purpura and blood platelets. The Departments of Protozoology, Endocrinology, Biochemistry and Nutrition have continued research work with great activity. The last has been particularly occupied with the standards of vitamins and the fundamentals of war-time diets.

Dr. A. N. Drury, F.R.S.

Dr. Alan Nigel Drury, who is to succeed Sir John Ledingham as director of the Lister Institute of Preventive Medicine on April 1, is a distinguished research worker in the field of experimental pathology. In its widest sense that term would, of course, include all the experimental studies of the mechanisms of infection and immunity which have attracted so large a part of the attention of research workers in pathology. Such studies must always provide an important part of the experimental foundations of preventive medicine, and many of the investigations which Sir John Ledingham has made and directed have been of this nature. There is another very important section of experimental pathology which focuses attention on the abnormalities of bodily function produced by diseases, whether these are due to infections or to other causes. Dr. Drury is one of the relatively few in Great Britain who have made the advancement of knowledge in this field of morbid physiology the chief object of their activities in research; and he has used to that end his opportunities of research in the clinic as well as in the laboratory.

Dr. Drury had begun research work at Cambridge, as George Henry Lewes student, in 1914. At the outbreak of war he left for St. Thomas's Hospital to complete his medical course, and having qualified, worked with the R.A.M.C. in India, becoming D.A.D.M.S. (Sanitary) on the Headquarters Staff. After the War he resumed, under the Medical Research Council, an association with Sir Thomas Lewis, begun early in the War, and worked with him from 1921 until 1927 on the action of the heart in health and disease, being particularly concerned with the mechanism of fibrillation and flutter of the auricles. After a temporary spell of ill-health he returned to Cambridge, becoming Huddersfield lecturer in special pathology, and remaining a member of the Medical Research Council research staff. From 1928 onwards, and until the outbreak of the present War, he was again called into organization—this time of war researches for the Medical Research Council. He was engaged in a series of important researches, largely concerned with abnormal functions of the heart and circulation. With Dr. L. J. Harris he discovered the bradycardia produced by defect of vitamin B_1 (aneurin), and with A. Szent-Györgyi he identified a hitherto unrecognized series of circulatory depressants in adenylic acid and related derivatives. Other researches led to the probable identification of a surface-active brain constituent which combines with tetanus toxin, and demonstrated the cardiac hypertrophy resulting from the formation of an arterio-venous anastomosis. Like his distinguished predecessors at the Lister Institute, Dr. Drury may be trusted to encourage and promote researches in the general field of preventive medicine, widely beyond the range of his own direct activities as an investigator.

Colonial Products Research Council

THE Colonial Office has appointed a Colonial Products Research Council, under the chairmanship of Lord Hankey. Unlike the Colonial Research Committee under Lord Hailey, the Council will be an executive body. It will consider what Colonial raw materials may be made of value for the manufacture of intermediate and other products required by industry, and it will initiate and supervise researches, both pure and applied, on such products, and generally consider how by the application of research greater use can be made of them. In framing its programme the Council will have as its principal objective the promotion of the welfare and prosperity of Colonial peoples, and will endeavour also to increase the Colonial contribution to the welfare and prosperity of the British Empire and of the world as a whole. In carrying out its programme, the Council will co-operate with existing institutes, such as the Department of Scientific and Industrial Research, the Medical Research Council, and the Agricultural Research Council, to the greatest possible extent, and will 'farm out' work to these and other bodies by arrangement; it will set up facilities of its own only for work which cannot be done by other means. So long as the war continues, the investigations which the Council will be able to undertake will necessarily be limited.

The Council is composed as follows: Mr. Eric Barnard, director of food investigation, Department of Scientific and Industrial Research; Capt. G. L. M. Clauson, assistant Under-Secretary of State, Colonial Office; Mr. Aneurin Davies; Dr. J. J. Fox, Government chemist; Prof. W. N. Haworth, professor of chemistry, University of Birmingham; Sir Harry Lindsay, director of the Imperial Institute; Sir Edward Mellanby, secretary, Medical Research Council; Sir Robert Robinson, Waynflete professor of chemistry, University of Oxford; Mr. G. W. Thomson, president, National Federation of Professional Workers; and Dr. W. W. C. Topley, secretary, Agricultural Research Council. Prof. J. L. Simonsen, lately of the University College of North Wales, has been appointed director of research. Certain members of the Council are also members of the Colonial Research Committee, and the Council will work in close touch with that body. It will be financed out of the provision for research in the Colonial Development and Welfare Act.

A Photographic Record of the Linnean Collections

THE value of the Linnean collections of animals and plants and of the associated books and manuscripts needs no emphasis. They must always remain of supreme importance to systematists, and the Linnean Society of London has very rightly regarded them as its own special charge. In April 1939 the collections were moved for safety to Woburn Abbey in Bedfordshire, and with the advent of bombing raids in 1940 the Linnean Society, through its Council, took steps for preserving a photographic record of the collections. A generous grant of about £2,000 was made to the Society by the Carnegie Corporation of America for this purpose and the work took active shape in the latter half of 1941. In order to facilitate the work the collections were removed in July of that year to the Zoological Museum at Tring, formerly the property of Lord Rothschild and now a department of the British Museum (Natural History). It was decided to adopt photographs on 35-mm. microfilm and, by this means, it was estimated that it would be possible to make a complete record of all the specimens, books and manuscripts in the course of about nine months. In addition, this would allow of a copy of the finished film being sent to the United States and possibly others elsewhere. As an indication of the extent of the task it may be pointed out that the estimated number of exposures in the case of the plants was 14,000, for the insects 5,000, for the shells 2,000, for the fishes 158, and for the books and manuscripts 30,000—making altogether more than 60,000 exposures. Good progress has been made, and it is probable that the whole of the work will be completed well within the estimated period. The details of the steps taken and how the various difficulties were encountered, together with the services rendered by various specialists, are recounted in an article on the subject by J. R. Norman in the *Proceedings of the Linnean Society* for 1941–42 (Part 1, pp. 49–57).

Investigations in Afghanistan

MR. K. DE B. CODRINGTON has recently returned from Afghanistan. He joined Josef Hackin, director of the French Archæological Mission, in the spring of 1940 and was present during his last season's work at Begram, the site north of Kabul which has produced such remarkable finds. M. Hackin left Kabul in the autumn of 1940 to join General de Gaulle's staff in London, and later lost his life at sea. Mr. Codrington interested himself in the Afghan Government's recent adoption of Pushto as the national language, and wrote an introductory grammar of Kandahari Pushto in collaboration with Colonel Muhammad Yaqub Khan. He speaks warmly of the Afghan Government's interest in archæology and history, and of the work of the staff of the Kabul Museum and the Kabul Literary Society, who are engaged upon a national history. Through the kindness of H.R.H. Sardar Naim Khan, the Minister of Education, and of H.R.H. Shah Mahmud, the Minister of National Defence, Mr. Codrington was able to make collections of flowering plants and varieties of wheat. He also contributed specimens of fishes to the Zoological Survey of India. Certain specimens of Afghan wheat are already being grown at Cambridge, and it is hoped to carry this work further, with the assistance of the Afghan authorities.

Vitamin Production in the U.S.S.R.

AT a Conference of Biochemists held in Moscow last November, attention was directed to the possibilities of utilizing the extensive walnut forests of Kazakhstan as an almost inexhaustible source of vitamin C. The unripe walnut contains an unusual quantity of ascorbic acid, and vitamin C is already being manufactured from it on a commercial scale. It is hoped that the systematic exploitation of the walnut forests for vitamin C production will be fully organized this year. Many hospitals in northern districts successfully use an infusion of pine needles as a means of supplying vitamin C. Other measures adopted since the War for increasing supplies of vitamins include the production of yeast (as well as protein) from food waste, the manufacture of vitamin B_6 from tobacco waste, and the utilization of certain freshwater fish as sources of vitamin D.

The Bed-Bug

ECONOMIC Series No. 5 of the British Museum (Natural History) is an illustrated brochure entitled "The Bed-bug: its Habits and Life-History and how to deal with it" (5th edition, 1942), by A. W. McKenny Hughes and C. G. Johnson. This insect, at the present time, is very prevalent in the larger cities wherein many areas are heavily infested. Large-scale evacuation of the population has resulted in the creature becoming established in wide areas previously uninfested. After the War it is likely that further redistribution of large numbers of people will again be necessary. Many complaints have come to hand about public shelters and similar places where people congregate during air-raids being infested. It is obtainable, price 6*d*., from the Museum or through a bookseller.

Some Problems in Transmission-Line Design

IN a paper with this title read in London on December 9 before the Institution of Electrical Engineers, Mr. A. Burke gives particulars of some of the serious damage caused by snowstorms to electrical transmission lines in Ireland, and of consequent departures from conventional design. The factors governing the examination of breakdown data are analysed critically and the data and conclusions for particular cases are stated briefly. Loadings are compared with those specified by the British Regulations for Overhead Lines, and the effectiveness of the universal method of controlling the factor of safety of conductors is challenged. The superiority of a horizontal over a triangular arrangement of conductors is viewed from a new angle and the reasons for adopting a horizontal arrangement on wood poles for 260 miles of 110 kV. line are given. Various problems in connexion with the design of this line are set out, costs are given and the conclusion is drawn that it is much more economical than a line carried on lattice steel towers.

Journal of the Society of Glass Technology

THE general adoption some years ago of the glass bottle for the delivery of milk to the household brought about a wide realization of the importance of glass in everyday life. A war-time shortage of metal has led to many replacements of metal-can by bottle. There is therefore much of general interest scattered through each number of the *Journal of the Society of Glass Technology*. The latest issue, vol. 26, No. 116, includes a fully illustrated paper on "Cords, Surface Condition and Quality of Glassware", as well as more than sixty pages of abstracts. The *Journal* is issued bi-monthly from the University of Sheffield, Northumberland Road, Sheffield, 10.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of two recent earthquakes. The first was on November 10 at 11h. 41·3m. U.T. and the provisional epicentre was latitude 35° E., longitude 46·5° S. This is in the bed of the ocean somewhat to the west of Prince Edward Island to the south of Africa. The second earthquake was on November 12 at 4h. 55·4m. U.T. and its provisional epicentre at latitude 16·8° N., longitude 94·2° W. This is in the high country to the east of Chimalapa in the Isthmus of Tehuantepec in Central America.

Comet Whipple

THIS comet is now a naked-eye object and has been observed in various parts of Great Britain. A new orbit has been computed by Dr. M. Davidson from observations extending over a much longer period than those which were used for the preliminary orbit given in NATURE of January 9, p. 51, and is more accurate than the earlier orbit. The comet will probably remain a naked-eye object for some time and will continue to move northwards until February 25, after which its declination will slowly decrease.

Orbit

$$\begin{array}{ll} T & 1943 \quad \text{Feb. } 7{\cdot}00 \text{ U.T.} \\ \multicolumn{2}{l}{\left.\begin{array}{ll} \omega & 40{\cdot}0^\circ \\ \Omega & 100{\cdot}1 \\ i & 19{\cdot}9 \end{array}\right\} 1943{\cdot}0} \\ q & 1{\cdot}354 \end{array}$$

Ephemeris

Date 1943	R.A. h.	R.A. m.	Dec.	ρ	r
Feb. 1	10	31·3	+49·7°	0·436	1·357
5		50·8	51·7	·442	·354
9	11	07·4	53·3	·452	·354
13		21·3	54·2	·465	·357
17		35·8	55·0	·479	·362
21		50·2	55·4	·495	·370
25	12	00·6	55·5	·513	·380

Announcements

PROF. JOHN ALFRED RYLE, regius professor of physic in the University of Cambridge, and physician extraordinary to the King, has been elected professor of social medicine in the University of Oxford.

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services: Prof. Emile Cammaerts, professor of Belgian studies and institutions in the University of London; Admiral Sir Andrew Cunningham; Prof. W. N. Haworth, professor of chemistry in the University of Birmingham.

THE People's Commissar for Education in the U.S.S.R. has instituted fifteen valuable Newton scholarships for Soviet university students. They are to be awarded to young men and women specializing in physics, mathematics, mechanics and astronomy. The Universities of Leningrad and Moscow will receive three scholarships each. Other Newton celebrations include exhibitions of portraits and books in English, Russian and other languages on Newton at the University of Moscow and the Scientists' Club.

A WEEK-END course on February 27 and 28 on factory medical services and industrial diseases for medical practitioners has been arranged at the London School of Hygiene and Tropical Medicine. The course will be opened by Sir Wilfred Garrett, chief inspector of factories, at 2 p.m. on February 27. The subjects of succeeding lectures are: industrial diseases of the lungs; skin lesions arising from coal distillation; the investigation of toxic hazards; a method of assessment of physical requirements for processes with reference to routine medical examinations; industrial fracture; and recent work on antiseptics. Applications to attend, with a fee of one guinea, must reach the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than February 22.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Penicillamine, a Characteristic Degradation Product of Penicillin

WE noticed more than nine months ago that acid hydrolysates of penicillin gave a strong blue-violet coloration with the ninhydrin reagent. Afterwards it was found that, under standardized conditions of hydrolysis, the colour intensity given by numerous penicillin preparations of varying degrees of purity ran parallel to their antibacterial activities except in the case of very crude specimens. It was also found that about 59 per cent of the total nitrogen of the purest preparations could be estimated as amino-nitrogen after one hour's hydrolysis by means of *N*/10 sulphuric acid under the conditions of the van Slyke method. These facts indicated that the substance responsible for the ninhydrin reaction and the positive results in the van Slyke amino-nitrogen determinations was a fundamental part of the penicillin molecule. Its isolation was therefore regarded as a matter of importance and we are now able to report that it has been obtained as a crystalline hydrochloride. The properties of this substance, which we propose to term *penicillamine*, show that it represents a novel type of naturally occurring base. Penicillamine is identical with the base which we have stated in an earlier communication[1] to occur in acid penicillin hydrolysates.

Penicillamine is obtained by hydrolysing barium penicillin (both 650 and 1,000 units/mgm. have been employed) at 100° C. for one hour by means of *N*/10 sulphuric acid, and the base is eventually precipitated from a concentrated solution by mercuric chloride. After de-mercurizing by hydrogen sulphide and evaporation of the solution at the room temperature under diminished pressure, a mass of homogeneous needles is obtained (yield, 30–40 per cent calc. on nitrogen content of penicillin). Analysis (Weiler and Strauss) of material dried *in vacuo* at 50° (loss, $1H_2O$) gave the formula $C_6H_{11}O_4N,HCl$; just conceivably $C_6H_9O_3N,HCl,H_2O$, although the salt did not lose water at 100° in a high vacuum. The molecular weight determined by X-ray crystallographic measurements (private communication by Crowfoot and Low) was in satisfactory agreement with the formulæ $C_6H_{11}O_4N,HCl,H_2O$ or $C_6H_9O_3N,HCl,2H_2O$. It is worthy of note that $C_6H_{11}O_4N$ is $C_6H_{12}O_6 + NH_3 - 2H_2O$.

Penicillamine appears to be optically inactive (19 mgm. in 1·3 c.c. of water) and we take this opportunity of correcting the statement that barium penicillin of 500 units/mgm. is lævo-rotatory; the substance is dextro-rotatory in aqueous solution. The electrometric titration curve of the new base shows the presence of three proton-binding centres, at *p*H 2·0, *p*H 7·9 and *p*H 10·5, respectively. These may be an acidic hydroxyl, the basic group, and a weakly acidic hydroxyl group. The nitrogen is present in an amino-group and is liberated (more than 90 per cent) as nitrogen with nitrous acid in five minutes under the conditions of the van Slyke method. The ninhydrin reaction is an intense bluish-purple coloration.

Other properties of penicillamine, however, are very different from those of the known amino-acids and even suggest a relation to an amino-sugar and ascorbic acid, optical inactivity in that event being due to racemization through enols. Naturally these unusual properties (see below) may be due to substituent groups and do not certainly exclude the presence of a carboxyl group. A typical α-amino-acid structure is rendered improbable by the slow and incomplete formation of carbon dioxide on heating with ninhydrin[2] at *p*H 2·5 (0·2 mol. in ½ hr., 0·3 mol. in 1 hr.; glutamic acid gave 0·95 mol. carbon dioxide in 12 min. under similar conditions). Penicillamine gives a deep blue coloration with ferric chloride which quickly fades owing to oxidation. It reduces ammoniacal silver nitrate on gentle warming and gives a green colour with Fehling's solution. It reduces iodine in cold acid solution, taking up rather more than two atoms of iodine. The change appears to be reversible; for example, the colourless solution renders iodine to ether. This experiment suggests oxidation of a hydroxy-enolic or amino-enolic system or N-iodination. On heating a solution of penicillamine and *p*-nitrophenylhydrazine in *N* hydrochloric acid at 100°, glyoxal-*p*-nitrophenylosazone is produced in about 20 per cent yield. This degradation indicates the source of glyoxal-*p*-nitrophenylosazone obtained in much earlier experiments when penicillin was heated in *N* acid in the presence of *p*-nitrophenylhydrazine. The natural explanation is that a glycollaldehyde fragment has been detached, but it should be observed that fission with formation of formaldehyde would also supply an explanation of this result[3]. In either case the reaction represents an unusual type of decomposition.

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Jan. 11.

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[1] NATURE, 149, 356 (1942).

[2] van Slyke, Dillon, Macfadyen and Hamilton, *J. Biol. Chem.*, 141, 627 (1942).

[3] Cf. Pechmann, *Ber.*, 30, 2460 (1897); 31, 2123 (1898).

Increase in Toxicity of Stilbamidine Solution on Exposure to Light

THE increasing use of stilbamidine (4 : 4′-diamidinostilbene di-β-hydroxyethane-sulphonate) for treatment of kala-azar in the Sudan[1] and India[2] makes the properties of this drug a matter of some importance. Kirk[3] reported that solutions of the drug which had been made up and exposed to light for some time appeared to have increased in toxicity. Fulton and Yorke[4] have confirmed this suggestion experimentally, and our own work, carried out independently as a result of Kirk's observations, has given similar results. Dilute solutions of stilbamidine (0·5 per cent), exposed to sunlight, increase in toxicity four- or five-fold in about four days, after which there is no appreciable further increase. Weak solutions (0·5 per cent) change much more rapidly than do stronger, but by subjecting 10 per cent solutions to the light from a mercury arc lamp for several hours, we have been able to prepare sufficient quantities of toxic solution for isolation of the material responsible for this toxicity.

The toxic diamidine is readily separated from unchanged stilbamidine by precipitating the latter as its sparingly soluble hydrochloride with excess hydrochloric acid. From the filtrate the toxic amidine is precipitated by excess caustic soda as a gum from which the hydrochloride and sulphate have been prepared in pure crystalline condition. Other well-defined salts include the picrate and picrolonate.

The product is almost certainly 4 : 4′-diamidino phenyl benzyl carbinol, but rigorous proof is difficult. This diamidine on heating loses water and ammonia to give *trans* 4 : 4′-dicyano stilbene. At one stage it was thought that the toxic product was *cis*-4 : 4′-diamidinostilbene, but this on heating yields cis-4 : 4′-dicyanostilbene. The different picrates obtained from the two amidines also indicated that this theory was incorrect. On hydrolysis the amidine obtained by irradiation gives an acid, which from analysis appears to be phenyl-benzyl-carbinol-4 : 4′-dicarboxylic acid ; this acid, on successive treatment with thionyl chloride and *o*-toluidine, yields a toluidide identical with that obtained from stilbene dicarboxylic acid similarly prepared.

The toxic product and its derivatives are thus readily converted back to the corresponding stilbene derivatives. The toxic amidine is colourless and exhibits only a slight fluorescence in ultra-violet light, whereas '*cis*-stilbamidine' exhibits an initial weak fluorescence which is intensified in a few seconds until comparable with that of the *trans*-compound.

It seems probable that the reaction occurring in aqueous solution is an addition of the elements of water to the double bond of the stilbene linkage. It is possible that the function of the ultra-violet light is first to convert some of the trans-stilbene to the cis-compound, which is the more reactive form.

It follows from the above, and the fact that other therapeutic diamidines have shown no such alteration in biological or chemical properties, that the change is associated solely with the unsaturated stilbene linkage, and that the amidine groups are not affected.

The biological results obtained with the isolated and purified toxic diamidine are in conformity with those of the exposed solutions. The symptoms produced in mice by the toxic substance were more stimulant in character than those caused by a freshly prepared solution of stilbamidine, which were mainly depressant. In general, the pharmacological effects shown by the toxic product differed quantitatively rather than qualitatively from those of the original substance. The depressor action in the anæsthetized cat was increased about five times, and recovery was delayed. Atropine only partially antagonized this effect, while the spleen was actively contracted. Smooth muscle of the rabbit intestine was sometimes contracted in concentrations of about 1 : 50,000, but after atropine, inhibition and relaxation were always produced; this differed from the effect of stilbamidine, which caused contractions which were only slightly reduced after atropine. The fall of pressure was probably mainly due to vasodilatation, since there was no depressant action on the isolated rabbit's heart. The isolated product had a toxicity in mice which was five times greater by intravenous injection, and ten times greater by subcutaneous injection, than stilbamidine. Of great importance was the observation that the toxic product was almost inactive therapeutically against *T. equiperdum.*

There are many interesting features of the phenomenon which we propose to examine at a more favourable opportunity. For example, it is almost certain that at least one other product of irradiation, a yellow compound, is formed in small quantities ; the appearance of a yellow colour in the solution is particularly marked in the case of slow irradiation in natural light. We also intend (in view of the findings of Kirk[3]) to see whether prolonged administration of therapeutic doses of the toxic product causes pronounced liver damage.

The nature of the changes occurring on exposure of solutions of stilbamidine emphasizes the necessity for use of freshly prepared solutions of this drug, especially when it is realized that a marked increase in toxicity is apparent after only two or three hours standing in daylight.

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[1] Kirk, R., and Sati, M. H., *Ann. Trop. Med. Parasitol.*, **34**, 83 (1940); **34**, 181 (1940).

[2] Napier, L. E., Sen Gupta, P. C., and Sen, G. N., *Indian Med. Gaz.*, **77**, 321 (1942).

[3] Kirk (private communication ; see (4) below).

[4] Fulton, J. D., and Yorke, W., *Ann. Trop. Med. Parasitol.*, **36**, 134 (1942).

Antimony Content and Toxicity of Urea Stibamine

UREA STIBAMINE, introduced by Brahmachari[1] in 1922 and widely employed in the treatment of kala-azar in India and elsewhere, still remains a compound with no definitely known and agreed chemical formula. It was originally reported to be a substance composed of urea and *para*-aminophenylstibinic acid with the empirical formula, $C_7H_{12}O_4N_3Sb$. Later it was suggested that the compound was identical with ammonium-*para*-carbamidophenylstibinate, $NH_2.CO.NH.C_6H_4.SbO(OH).ONH_4$ [2]. Ghosh *et al.*[3] and Gray *et al.*[4] gave definite evidence that urea stibamine was not a single substance of definite composition and the latter group of workers showed that the 'effective active principle' was a di-substituted urea, *S*-di-phenyl-carbamide-4 : 4 distibinic acid. The antimony content of various commercial samples was shown by Ghosh *et al.* to vary between 20 and 43 per cent, while Gray *et al.* reported a comparatively smaller range of variation in antimony content from 44·19 to 48·6 per cent. Brahmachari[5] appeared to have accepted the results of Gray *et al.* in this regard, and emphasized that the divergent results obtained by different investigators were due to different brands of "so-called urea stibamine", not conforming to his original specifications; being put on the Indian market.

In connexion with the routine testing of drugs on behalf of the Director-General, Indian Medical Service, this laboratory had an opportunity, during the years 1940–42, of testing more than a hundred samples (with different batch numbers) of urea stibamine manufactured by the Brahmachari Research Institute, Calcutta. Chemical assay for antimony content (Ghosh[6]), and toxicity tests (Burn[7]) on white mice were regularly carried out. In a few specimens, survival time of infected mice (*T. equiperdum*) was also recorded according to the method of Gray *et al.* (*loc. cit.*).

A critical analysis of our data shows that, in general conformity with the findings of Gray *et al.*, the antimony content of urea stibamines (Brahmachari) is fairly constant and lies between 39 and 42 per cent. In only five instances (out of 100 analyses) was a figure above 42 per cent (but less than 44) found. In only one case, a figure below 39 per cent antimony was obtained. However, our maximum figure was definitely *lower* than the minimum figure (44·19 per cent) of Gray *et al.*[4].

Napier[8] found that the lethal dose of urea stibamine for mice was 250 mgm. per kgm. body weight. Though an accurate statistical analysis of our mean lethal dose figures has not yet been made, it is possible to state that in the majority of our experiments a toxicity figure varying between 200 and 225 mgm./kgm. was recorded. The maximum tolerated dose was often in the neighbourhood of 150 mgm./kgm. and seldom exceeded 170 mgm./kgm. Specimens containing a higher antimony content apparently showed a higher toxicity and stronger therapeutic effect, but a statistically significant relationship between antimony content and toxicity could not be established.

Work is in progress to find out whether, in view of its fairly constant composition (within the limits stated above), urea stibamine can be employed as a *standard* for evaluating the potency of other pentavalent organic antimony compounds of similar composition manufactured in India. The absence of an international standard of unvarying composition for antimony, as in the case of organometallic compounds of the arsenic group, is keenly felt by workers engaged in drug standardization in India.

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Brahmachari, *Ind. J. Med. Res.*, **10**, 492 (1922).
Niyogi, *J. Ind. Chem. Soc.*, **5**, 753 (1928).
Ghosh *et al.*, *Ind. J. Med. Res.*, **16**, 461 (1928).
Gray *et al.*, *Proc. Roy. Soc.*, B, **108**, 54 (1931).
Brahmachari, NATURE, **145**, 1021 (1940); **145**, 546 (1940).
Ghosh, *Ind. J. Med. Res.*, **16**, 457 (1928).
Burn, "Biological Standardization", 252 (1937).
Napier, "Kala-azar". 2nd Edit. (London, 1927).

Configuration of Purine Nucleosides

HENDRICKS[1] has measured the interplanar cleavage spacings, *d* (001), of a number of organic salts of the clay mineral montmorillonite by means of nickel $K\alpha$ radiation. Among the cations studied were those of the purine bases guanine and adenine and the corresponding nucleosides guanosine and adenosine, which are 9-guanine *d*-ribofuranoside and 9-adenine *d*-ribofuranoside respectively[2]. By his measurements Hendricks showed that the arrangement of the atoms of the two purine ions is coplanar, thus confirming the view which is reached from consideration of molecular models. He also concluded that the nucleoside ions have a van der Waals 'thickness' between oxygen centres (of montmorillonite) only about 1·0 A. greater than would be required for a strictly coplanar atomic arrangement, and that the purine and sugar radicals of the nucleoside ions lie in two parallel planes about 1·5 A. apart, with the majority of the atoms lying probably in or near the two planes; one plane contains the purine radical, the other the ribose ring, and it is held that the hydroxyl groups as well as the primary alcohol group must be approximately in the plane of the purine radical, in order to accommodate this close lateral packing of atoms.

Hendricks thus postulates that in the nucleoside montmorillonites the hydroxyl groups at C_2 and C_3 of the pentofuranoside and the primary alcohol group C_5 are in the *cis* relationship with reference to the plane of the furanose ring, whereas in the ribofuranosides the configuration is such that the hydroxyl groups are both *trans* to C_5; in fact, the sugar shown in Fig. 8a[1] is not a ribofuranoside but is a lyxofuranoside. Nevertheless it is generally accepted that the sugar in these nucleosides is *d*-ribose, and further proof of this identification will shortly be published elsewhere in so far as the pentose of the four nucleotides of the ribonucleic acid of yeast is concerned. Nucleotides from other sources are being similarly examined.

Consequently, there would seem to be two alternatives. (1) The sugar in the nucleoside ions examined was actually *d*-ribose; if so, the conclusions of Hendricks may require revision to accommodate the fact that either two hydroxyls or one primary alcohol group, depending on the as yet unsettled α- or β-configuration of the glycosidic linkage, will lie outside the plane of the furanoside ring, *trans* to the purine radical and at a distance from the furanose plane about the same as that separating it from the purine plane. (2) The sugar in the nucleoside ions examined was in fact α-lyxose; in this case the position would be that the pentose in the nucleosides (nucleotides) may not always be *d*-ribose, a possibility which we have suspected for some time. In this connexion it may be mentioned that two of us have isolated *l*-lyxose in the form of a derivative from yeast ribonucleic acid; the details and significance of this observation will be discussed elsewhere. The material source of the nucleosides examined by Hendricks was not stated.

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Dec. 29.

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[1] *J. Phys. Chem.*, **45**, 65 (1941).

[2] See Gulland, *J. Chem. Soc.*, 1722 (1938).

Newt Larvæ in Brackish Water

IT is generally believed that amphibian larvæ are not found in salt or brackish waters, and therefore the following observation seems interesting.

On August 7, 1942, newt larvæ were observed in one pool of the many on the western side of Carradale Bay, Argyll. The pool was about nineteen yards from the nearest salt water pool on a gently sloping shore. Its bottom consisted of rock and shingle and it was surrounded by turf. It was fed by rain and seepage. A sample taken contained chloride equivalent to 0·28 per cent sea water. This is regarded as a fresh water.

On August 18 a neap tide came to within nine yards of the pool. During the night of August 18–19 there was a considerable wind, and judging from the line of jetsam the sea had reached this pool, which had increased in size. It was measured roughly on August 20. It was L-shaped round the base of a large rock. The long arm of the L, parallel to the sea, was about 20 ft., and the short arm, directed landward, 10 ft. long. It was less than 4 ft. wide and the greatest depth was less than 3 ft.

The water was visibly layered. A sample from the shallower parts contained 5·6 per cent sea water and from the bottom of the deep parts 68·3 per cent sea water. The newts congregated in the lower levels of the shallower parts, but occasionally swam through the deep water. Thirteen newts lived twenty-four hours in the 5·6 per cent sample, but one newt put into the 68·3 per cent died within 1 hour 40 minutes. On August 20, after rain in the night, no dead newts were seen in the pool and a further sample of unanalysed shallow water was taken and added to the 5·6 per cent sample. The newts lived in this until August 22, when it was diluted with the 0·28 per cent sample.

One larva metamorphosed and left the water on August 26, and others did so in the next few days. Therefore the newts seem to have completed their larval development in conditions in which the salinity could rise considerably.

I think there were between 100 and 200 larvæ in the pool. They were of many different sizes.

According to the taxonomic tables of Werner and Herter in "Fauna von Deutschland", edited by P. Brohmer, the larvæ were of *Molge palmata*.

The only other common animal in the pool was a species of Gammarus which did not avoid the salter layers. According to the criteria of Chevreux and Fage, "Faune de France", **9**, and of Stephenson, "Tierwelt der Nord und Ostsee", **10f**, the species was *duebeni*, but the taxonomy of this genus is still fluid.

I wish to thank Mr. J. B. Cragg of the School of Agriculture, University College of North Wales, Bangor, for analysing my samples.

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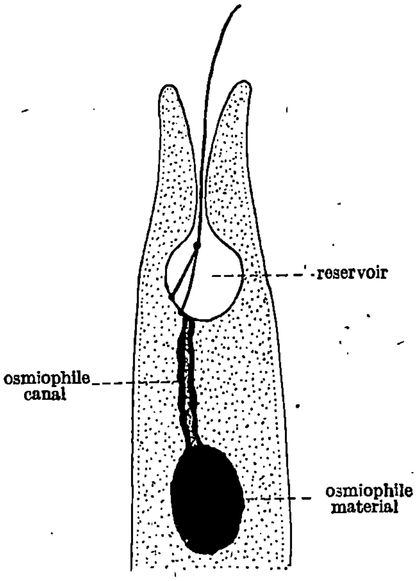
Golgi Apparatus in *Astasia Harrisii*

IT is well known that in numerous Protozoa, the contractile vacuole is associated with an osmiophile cortex, which is believed to be homologous with the Golgi apparatus of metazoan cells. In Paramecium, it has been shown by Nassonow[1] that the secretory canals leading into the contractile vacuoles are osmiophilic in nature, and are considered to represent the Golgi apparatus in this form. Although many Protozoa possess similar canalicular systems, canals with osmiophile walls have never since been demonstrated in any other Protozoon, although a great number have been investigated.

By making Golgi preparations of *Astasia Harrisii* (Pringsheim), a euglenoid flagellate, using the usual Weigl technique for Protozoa[2], I have shown that such an osmiophile canal is present in this organism. It runs from the base of the reservoir, ending in a large mass of osmiophile material approximately spherical in form.



Its general morphology is very similar to that of a single canal of Paramecium, being globulated throughout its length, and is evidently concerned with secretion or excretion into the reservoir.

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Jan. 2.

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[1] Nassonow, D., *Arch. Mikr. Anat.*, 103 (1924).

[2] Gatenby, J. B., and Smyth, J. D., *Quart. J. Micro. Sci.*, 81 (1940).

The Encephalophone: a New Method for Investigating Electro-Encephalographic Potentials

THE usual methods for investigating electro-encephalographic potentials consist in applying the amplified potentials from the head either to a directly recording oscillograph or to a cathode ray oscillograph with photographic recording. The permanent records thus obtained are of value for the purpose of research into the physiological and pathological functioning of the brain, and the results of such researches are becoming of definite clinical value. We wish to suggest a new apparatus for use in the clinical application of electro-encephalography as distinct from the application to research, where recording instruments are essential; it is meant, at its present stage, merely as an auxiliary to the established methods.

The principle of the suggested method is to convert the potential changes from the head into changes of pitch of a musical tone. In an instrument constructed by us, this tone is produced by two independent high-frequency valve oscillators of slightly different frequencies of the order of 5 mc./sec. These are 'mixed' by means of a mixer valve, thus producing a beat frequency equal to the difference between the two high-frequencies. If this beat frequency is in the audio range, it can be made audible as a tone of certain pitch in a loud speaker or pair of earphones. One of the two high-frequency oscillator circuits is connected to a 'frequency modulator' valve which acts in such a way that a change of the control-grid potential of this valve produces a change in frequency of the oscillator to which it is attached. This results in an alteration of the beat frequency and thus in a change of pitch of the tone heard. The potentials from the head are amplified in the usual way by means of a linear amplifier designed for very low frequencies, before applying them to the frequency modulator valve. We propose to call this instrument an 'encephalophone', following a suggestion by Dr. George Dawson.

The instrument has been tried out and found to work very satisfactorily. Both 'alpha' rhythms and 'beta' rhythms give characteristic trills, while the three per second and other slow waves usually met with under pathological conditions produce correspondingly slow sweeps of tone which are very striking and readily appreciated. There seems little doubt that the method is adequate for most diagnostic purposes to which the graphic method has so far been successfully applied. Further, there are some distinct advantages of the audio method over the present graphic ones. The apparatus, consisting of valves, batteries, etc., can be built in one compact unit, which is very inexpensive and easily portable. Secondly, in the audio method the observer's visual system is left free to watch for the slight movements of the subject's body which produce artefacts in the electro-encephalic potentials; this is of especial value in the examination of non-co-operative subjects.

As a possible future development, the two ears of the observer might be used for two 'channels'. The inputs to these two channels could be taken from symmetrical regions in the two hemispheres of the head, and it is probable that a departure from symmetry in frequency or size of rhythm, or even in phase, could be detected in this way. The observation of phase-relationships in any two regions could also readily be undertaken by the audio method employing two channels.

Our thanks are due to the University of Edinburgh, to the Rockefeller Foundation and to Mr. Norman Dott for the opportunity of doing this work.

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The Eclipse of the Sun in A.D. 45

ON the few occasions when eclipses of the sun are stated to have been predicted in ancient history, it has generally been found that these took place in the afternoon and could have been predicted as recurrences of the eclipses seen in the morning eighteen years earlier. This argument cannot be applied to the eclipse of August 1, A.D. 45, which certainly took place in the morning at Rome. It could not have been predicted from the eclipse of July 22, A.D. 27, which was not visible in any part of Europe. The assertion is that the Emperor Claudius issued a proclamation stating that the eclipse was expected, with full explanations, so that it should be regarded as a natural event and neither a prodigy nor a bad omen. Both the Emperor and his scientific adviser must have been quite certain of their facts, because they could not take any risk of failure.

I am not aware that anyone has investigated this eclipse before me, and I was rather surprised and impressed when my calculations led to the result that it took place in the morning. It must be inferred that the knowledge of astronomers at that time concerning the eighteen-year period was something more than the simple and elementary ideas usually ascribed to them. They must have understood that eclipses inevitably recur at these intervals, although they may be visible only in distant parts of the earth. If they really knew that after three such periods the eclipse must reappear in its former locality, we have to believe that they had some knowledge of the dimensions of the earth and of that which we now call longitude.

At Rome the maximum phase was at 10.36 a.m., local mean time, and the magnitude thereof was 0·35 of the sun's diameter. The central line, where the eclipse was total, passed a long way south of Italy, far down in Africa. As to who the learned man who coached the Emperor may have been, I would suggest that while there was a frequent service of shipping between Ostia and Alexandria, bringing grain to Rome, it would be easy to communicate with the astronomical fraternity in Egypt, as Julius Cæsar actually did, when requiring advice on the subject of reforming the calendar, a century before Claudius.

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Sir Henry Miers

SHOULD it not be recalled that Sir Henry Miers gave the clue for the discovery of terrestrial helium? In 1868, Norman Lockyer, founder and first editor of NATURE, observed in the spectrum of a solar prominence the characteristic yellow line of helium, previously unknown. In 1888, Dr. Hillebrand, of Washington, discovered that the mineral uraninite treated with sulphuric acid gave a gas which he suspected to be nitrogen. On the discovery of argon in 1895 by Rayleigh and Ramsay, search was made for sources of nitrogen, and Miers suggested to Ramsay examination of the gas discovered by Hillebrand. Ramsay sent a sample to Crookes for spectroscopic analysis: Crookes said "This is helium".

Last year, I congratulated Miers on his long innings, suggesting that he could survey his Agar's Plough with satisfaction and that in giving the clue for the discovery of helium, he hit the ball over the pavilion. "Oh, no!" he replied with characteristic modesty, "the helium episode is only a timid but lucky swipe which happened to sneak through to the boundary." In another letter he declared, "I don't really care two straws about credit for what was really a fluke".

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RESEARCH ITEMS

Avian Phylogeny

As the result of detailed anatomical investigations, more especially into the flexor carpi ulnaris, flexor sublimis digitorum and other muscles in the struthious birds and the Tinamous, Percy R. Lowe (*Proc. Zool. Soc. Lond.*, B, **112**; 1942) has come to certain general conclusions regarding the relationships of these groups to the rest of the birds (the Neognathæ). The author states that his findings do not favour the view, associated particularly with the names of Fürbringer and Gadow, that the various groups of struthious birds have evolved independently, but on the contrary they are to be regarded as a more closely knit group. Moreover, it is not possible to regard them as having arisen from a volant stock that has become modified owing to the loss of the power of flight. Among other things, the sternum ossifies from two centres one on each side related to the fused ends of the ribs, and there is no sign of the median Lophosteon from which the keel of the sternum of the carinate birds develops. Nor is neoteny, as de Beer suggested, an explanation of the conditions found in struthious birds, for the arrangement of the muscles bears practically no resemblance to those of the chick in any flying bird; it is on an altogether lower plane and gives no indication of an ancestral power of flight or the possibility of the development of such a power in the adult. The tinamous (Crypturi) also are to be looked upon as Palæognaths, but volant types where the attempt at flying was more successful than in other types, and even at that not so successful as in the case of the characteristic carinate birds. While the bones in the palate of Hesperornis are not satisfactorily established, the author suggests they are probably to be regarded as aquatic Palæognaths.

Nephridia of Earthworms

To zoologists whose knowledge of the excretory system of the Oligochæta is based upon the condition in Lumbricus it may come as somewhat of a surprise to learn that the terminal portion of the nephridium, the bladder, is not present in a number of genera. It is still more surprising to learn of the great variety of form and arrangement of the nephridia that are to be found within the limits of the group; indeed they are more variable than any other organs. Two main types are to be recognized, which Bahl has termed exonephric and enteronephric types; the former opening directly or by means of a longitudinal, common duct to the outside and the latter opening by means of ducts into the lumen of the gut. K. N. Bahl (*Quart. J. Micro. Sci.*, **83**, Pts. III and IV; 1942) has provided a description of the nephridia in the sub-family Octochætinæ, and this is prefaced by a useful review of the various types of nephridia encountered in the Oligochæta and also some details as to their development. The same author in the same journal has a second paper dealing with the multiple funnels in the nephridia of *Thamnodrilus crassus*, *Hoplochœtella bifoveata* and *Lampito* (*Megascolex*) *mauritii*, which form an interesting, graded series.

British Species of Ephemeroptera or Mayflies

Scientific Publication No. 7 of the Freshwater Biological Association of the British Empire is entitled "Keys to the British Species of Ephemeroptera with keys to the Genera of the Nymphs", by D. E. Kimmins, Dept. of Entomology, British Museum (Natural History), 1942. The appearance of this well-illustrated pamphlet will be welcomed by entomologists and others, since it provides for the first time a reliable means of identifying these insects. It should stimulate their collecting and observations so that an accurate idea may be obtained regarding the distribution of the different species. Altogether forty-seven species are claimed as being British, but there is no doubt that intensive collecting and observation will bring to light others in the future. Knowledge of the nymphs or immature mayflies is as yet insufficient to enable satisfactory keys to be devised for the determination of the various species. It is for this reason that a key to the identification of the genera only is provided. Most species of mayflies occur in Britain, under suitable conditions, in enormous numbers, and in all stages of their life-cycle they form a very important constituent of the food of freshwater fishes. This and other publications of the Association are free to members of that body. To non-members it is obtainable from the Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland, price 2*s.* 6*d.* Membership of this body, it may be added, is open to any who sympathize with its objects, the minimum annual subscription being £1.

Oxidation of Ascorbic Acid in Tea

During an inquiry into the suitability of certain articles of food as carriers of ascorbic acid, it was found that condensed milk, to which synthetic ascorbic acid had been added, lost its antiscorbutic activity when mixed with tea. In their efforts to prevent this destruction, G. A. Snow and S. S. Zilva (*Biochem. J.*, **36**, 641; 1942) established that inactivation of the ascorbic acid was due to the presence of certain non-metallic organic compounds, associated with the tannin fraction, capable of catalysing the oxidation of ascorbic acid in the presence of oxygen. Commercial gallic acid showed some activity, whereas *d*-catechin, tannic acid catechol, quinol and pyrogallol were almost inactive. Milk, egg albumen, cysteine and to some extent dimedone, inhibited the catalytic activity, and sodium chloride and potassium iodide accelerated it. Substances of a similar catalytic nature may be present in other vegetables and fruit tissues either originally or after treatments such as cooking or drying. For example, aqueous acetone extracts of the root and stem of rhubarb, and aqueous infusions of the dried leaves of rhubarb and camellia were active. Should the presence or formation of these catalytic substances in vegetables and fruits be fairly common, it would add one more factor to those which have to be considered in connexion with the stability of vitamin C in vegetables and fruits.

Comparative Morphology of the Algæ

Numerous cases are reported of parallel development among algæ; in this connexion stress is usually laid mainly on the simpler types of plant body, but F. E. Fritsch now directs attention to the very wide occurrence of the heterotrichous habit among those algal groups which have attained a higher degree of specialization than the simple filament (*Ann. Bot.*, N.S., **6**, No. 23; July 1942). Though exhibited in many algal groups, this habit is perhaps of most interest to follow in the Phæophyceæ and Florideæ; here the heterotrichous condition appears as the adult form or as a juvenile condition in the Ectocarpales and Nemalionales, but the prostrate system tends to become reduced and finally to disappear in the most specialized members of the groups (for example, Ceramiales), but persists in intermediate groups, especially in the gametophyte. The filamentous stages of some of the larger Ectocarpales, derived from spores from plurilocular sporangia on the sporophytes (plethysmothalli), seem best explained as sporophytes arrested for a considerable time in the heterotrichous, juvenile condition and distinct from the filamentous gametophytes derived from spores from unilocular sporangia. Cutleria, which is exceptional among algæ in showing alternation of two different macroscopic phases, shows, in intermediate forms which are described, evidence of origin from a heterotrichous type, in which the sexual generation has lost the prostrate, and the asexual the erect, part of the system, though traces of the latter persist as the column which is formed early in the development of the 'Aglaozonia' stage sporophytes.

Factors in the Production of Leaf Palisade Tissue

A VERY interesting contribution to our knowledge of this subject is made by R. W. Watson (*New Phyto.*, 41 (3), October 1942). Using cuttings of the juvenile form of ivy, it was possible to initiate the production of palisade in fully expanded leaf blades by transferring them from a shaded to a brightly lit habitat. If transfer was sudden the layer of mesophyll cells immediately below the upper epidermis, with the exception of those nearest to the veins, might be killed, evidently through desiccation. A more gradual or less violent adjustment of light was shown first by an accumulation of starch, then in the upper cell ayers starch disappeared with a growing concentration of sugar in the cells, and this was followed by water absorption and an increase in length at right angles to the leaf surface as characteristic palisade tissue was developed.

Luminosity a Mendelian Character in a Fungus

RUTH MACRAE confirms (*Canad. J. Res.*, 20(8), August 1942) previous observations that whereas the mycelium of *Panus stypticus* in Europe is non-uminous the North American form is luminous. Both forms are heterothallic and all pairings between monosporous mycelia from the two forms seem to be fertile. It has thus been possible to show, by crossing luminous and non-luminous forms, that this s an inherited character governed by a single pair of Mendelian characters and that luminosity is dominant and is expressed as a dominant character n the binucleate mycelium in the *F*1 generation.

ystems with Boron Trifluoride

THE boron atom of BF_3 acts as an acceptor of lectrons to form a large number of co-ordinate compounds. Atoms which act as donors of electrons are arbon, nitrogen, oxygen, fluorine, phosphorus, ulphur and argon. H. S. Booth and D. R. Martin *J. Amer. Chem. Soc.*, 64, 2198; 1942) find that HCl nd CH_3Cl give only eutectics and no compounds with BF_3, so that the reported compound $BF_3,3HCl$ s non-existent. Nitrous oxide N_2O forms no compound with BF_3. Sulphur dioxide SO_2, as in the ase of solvents H_2O and NH_3, forms a compound BF_3,SO_2 and two eutectics. The structure suggested is an ionic one $[SO]^{++}[OBF_3]^{--}$ analogous to the monohydrate $H^+[HOBF_3]^-$, although the formula $O_2S \rightarrow BF_3$ is also possible and would agree with the formation of the compound $H_2S \rightarrow BF_3$.

X-Ray Elasticity Measurements for Mild Steel in Compression

THE X-ray study of elastic properties of metals is continued in a paper by S. L. Smith and W. A. Wood (*Proc. Roy. Soc.*, A, 181, 72; 1942). Mild steel specimens were used in a standard 10-ton testing machine, and the X-ray tube was built up alongside in a position suitable for taking back-reflexion photographs. The external strain measured by an extensometer was compared with the changes in diameter of a sensitive X-ray diffraction ring formed by back-reflexion of beams incident perpendicular to the length of the specimen and to the direction of stress. It is concluded that the lattice possesses a yield point also in compression, again marking the onset of a permanent lattice strain. The direction of this strain is opposite to that found in tension and the magnitude increases systematically with the applied stress. Experiments on pure iron suggest that the mechanics of the metallic lattice involve the principle that, after the lattice yield point, in a given direction the lattice systematically assumes a permanent strain in such a sense as to oppose the elastic strain induced by the applied stress.

Abrasion Test for Textile Threads

A. C. WALKER, writing on this subject (*Bell Lab. Rec.*, 21, No. 1; September 1942), refers to studies made in the Bell Laboratories on the resistance to abrasion of threads of different materials such as are used for the braided covering of telephone cords, and of treatments to improve the life of the braids. One test is carried out by an abrasion apparatus which wears threads or braids until they break, the time required serving as a measure of wearing qualities. Threads tied in endless loops are suspended from hooks fastened to a stationary cross-bar. Square weights are hung from the loops and the threads are then arranged about staggered pins mounted on a movable plate, being looped around the middle pin so that they twist together in a sharply bent loop. As the movable plate oscillates up and down under the action of a motor-driven cam, it rubs the threads against each other and wears them at the sharp bend. It is important to have two threads in parallel to minimize the tendency of the single strands to twist and untwist during the rubbing action. The threads are prevented from twisting about one another by resting the square weight lightly against a backing plate. The cabinet which encloses the apparatus is air-conditioned for controlled humidity and temperature. Seventeen samples can be tested at a time. One of the chief limitations to the reproducibility of results attainable in testing textiles is the lack of uniformity in the materials. In measuring the abrasion resistances of spun mercerized cotton used for telephone cord braids, the method described gave consistent results within ± 15 per cent of the average for groups of seventeen samples. This is considerably better than might be expected on the basis of the variability in the spun yarn, as shown by analyses of the results of several hundred tests. Because the time required to test threads is short compared to testing finished cords, this method lends itself to rapid preliminary studies for improving wearing qualities.

AGRICULTURAL EDUCATION ASSOCIATION

ANNUAL CONFERENCE

IT was quite evident from the attendance at the Midland Agricultural College during January 4–6 that the Council's decision to resume the normal conferences was a popular one, for some seventy-five members arrived to take part in the discussions. Two years ago it had been decided to suspend most of the activities of the Association because of difficulties consequent upon numerous members being drafted from their usual activities into the service of war agricultural executive committees, to the disorganization of agricultural colleges and university departments due to changes in policy thrust upon them in the early days of the War, transport difficulties and so on. But as time went on, it became obvious that the multitudinous problems now besetting the agricultural scientist and educationist would have to be discussed by as many people as possible, and the recent conference was the outcome of the demand.

Prof. R. G. White, University College of North Wales, Bangor, presided at the two paper-reading sessions. It is not possible to do more than indicate the general lines of the more important matters discussed, but the papers presented will be published in full in the Association's journal *Agricultural Progress*. The discussion which took place upon agricultural education in rural areas is not included in this brief summary, but will receive special attention in another issue of NATURE.

Three papers of outstanding value dealt respectively with drainage, seeds and milk. On the subject of drainage, Mr. H. H. Nicholson, of the School of Agriculture, Cambridge, dispelled any feelings of complacency there might be in various quarters by stating that we are not draining agricultural land in Britain very much faster than we were during the period 1864–72; at that time some 44,000 acres annually were being intensively 'tile drained', whereas now, at a time when we are fighting for our lives on the agricultural front, only about 124,000 acres have been scheduled in two years, and the drainage could scarcely be called intensive. He complained, too, of the timid approach to mole draining in many counties. Soil conditions for mole draining, he said, are at their best in March, April, May and June, when the surface is firm enough to allow easy passage of implements and the subsoil is moist enough for the mole to function properly. He deprecated the warning off of the mole plough during these months simply because the ground is occupied by a straw crop, for in his opinion very little damage would be done to the crop by moling over it. He would like to see more attention being paid to the principles of drainage in agricultural courses at colleges and universities.

The vital question of seed supply in war-time received attention from Mr. L. E. Cook, executive officer to the Seed Production Committee of the Ministry of Agriculture. He showed first that in normal times we receive seeds from all parts of the world and produce only a small amount ourselves. At the outbreak of war, we were cut off from European supplies, while supplies from America and New Zealand and other countries were gravely threatened. To ensure sufficient seeds the Government has had to interfere with the usual trade arrangements whereby individual firms buy where and as they choose, and substitute a system whereby the Government does all the buying in the national interest. Mr. Cook stressed the necessity for looking well ahead when dealing with seeds, saying that the next planting of seeds for seed crops such as mangold, onion, sugar beet will not produce seeds for sowing until 1945, and that from the sowings of cocksfoot in the spring of 1943 a full crop of seed will not be available for use before the spring of 1946. On the home production front, there are now twenty-seven seed growers' associations in existence, and the Government has fixed acreage targets for many kinds of home-produced seeds. The all-important thing is to have a sufficiency of seeds, and this may mean excessive production in a favourable seed-producing year; it is consequently necessary for growers' prices to be safeguarded.

In two closely related papers, Prof. H. D. Kay and Dr. J. G. Davis, of the National Institute for Research in Dairying, explained the National Milk Testing and Advisory Scheme. Prof. Kay described how in the early part of 1942 an advisory committee representative of the Ministries of Agriculture, Food and Health, of the Milk Marketing Board, the National Farmers' Union, the Central Milk Distributive Committee and the County Councils' Association prepared a nation-wide scheme to maintain a satisfactory standard of quality for all milk supplies; to reduce loss of milk from souring; to arrange for unsatisfactory milk to be manufactured or otherwise salvaged, or to be rejected and returned to the producer; to provide a basis for the introduction as soon as possible of a scheme of differential prices to producers in accordance with the keeping quality o the milk, and to provide information to enable county and provincial advisory services to be used to the best advantage. Such a scheme had become urgently needed because of the enormous amount o milk which is being lost every summer in Grea Britain through premature souring, a loss which i destroying the efforts being made throughout the country to increase milk production.

Before such a scheme could be put in operation i was necessary to devise some simple and *rapid* tes in order to weed out milk that fell below a certain standard. Dr. Davis described how in 1941 a comparison of all the recognized quick tests was completed by a panel of advisory dairy bacteriologists with the result that the 'ten minute resazurin test was officially recognized. Prof. Kay claimed that in spite of war-time difficulties and the fact that th whole country has not yet been covered, the schem is already bearing fruit. Two of its main objects ar to improve the standards of the lower 50 per cent o milk producers in Great Britain who have hithert had little help or advice, and to better the techniqu of milk handling in the many larger and smalle collecting units where methods are at present unsound. He saw a point of very great significance in that here, probably for the first time in the history of dairying, all sides of the industry and all th Government departments concerned are freely co-operating to achieve a single purpose, the permanen improvement in the keeping quality of the nation' milk supply. A later speaker described this schem as a perfect example of the application of science t a particular problem—first the examination of th data, then the search for a solution and the testin thereof, and finally the devising of machinery to apply the solution to the industry as a whole.

Another paper of considerable scientific interest was contributed by Mr. W. Morley Davies, of Harper Adams Agricultural College, who reviewed the present knowledge of crop failures caused by deficiencies of the minor elements in the soil. Such failures have been noticed in very many counties, and although they cannot be regarded at present as of major economic importance in the British Isles, further information concerning them is greatly needed. The commonest deficiency diseases in crops are those due to shortages of manganese, magnesium, boron and iron, and Mr. Davies was able to describe, with the aid of slides in colour, the characteristic symptoms of each disease. When recognized, the first three diseases can be controlled by application of manganese salts, magnesian limestone and borax, respectively. Mr. Davies mentioned that, certainly in the case of manganese and boron deficiency, over-liming tends to accentuate the symptoms, and while it is to be hoped that this statement will not interfere with the liming programme that is so urgently needed in many parts of Great Britain, it must be recognized that in certain circumstances and on certain soils lime is definitely harmful. One complaint caused, not by a deficiency but by an excess of a minor element, is 'teart'. Teart describes the scouring which takes place when cattle are turned out on certain pastures in Somerset, Warwickshire and elsewhere. It has recently been discovered that excess of molybdenum in the herbage of such pastures is responsible for the trouble; dosing the cattle with small amounts of copper sulphate is the remedy.

Wireworm problems were dealt with by Mr. W. E. H. Hodson, of the University of Reading, and Mr. D. J. Finney, of Rothamsted Experimental Station, the latter applying himself more to the statistical examination of data provided by the recent wireworm survey. From these two papers it appears that the present method of sampling fields for wireworms is reasonably accurate; it involves the collection and examination of twenty randomized cores, each 4½ in. in diameter and 6 in. deep, per field (fields of more than 50 acres are treated as two fields). Populations below 300,000 per acre can be disregarded except for maincrop potatoes; populations between 300,000 and 600,000 are dangerously high for many crops; between 600,000 and a million wireworms per acre are likely to be serious, while populations of more than a million render the likelihood of a good crop fairly remote. The speakers did not claim that the wireworm problem has been solved, but much progress has been made. As Mr. Hodson pointed out, the mere knowledge of a high population leads to extra care and extra cultivation, and so there is a better chance of a good crop.

In a summary of the present position of silage-making, Mr. W. McLean, of the University College of North Wales, thought that the actual making of silage demands greater attention than has hitherto been given to it. The results achieved to date indicate clearly that the underlying principles of the modern silage process must be more thoroughly understood by farmers in general before good quality silage can be produced generally. He thought that the 1940 silage campaign had rushed the farmers into an improperly understood operation, and the consequent failures had done the movement much harm.

Speaking on the subject of artificial insemination centres for dairy cows, Dr. S. Bartlett and Dr. J. Edwards said that the advantages of artificial insemination are now widely appreciated, and these are particularly evident in the case of small dairy herds where the keeping of a bull is uneconomic. Two Government-sponsored centres are in existence, at Cambridge and at Reading, and these are expected to yield information of considerable value and to provide pointers for lines of future development. Shorthorn and Friesian bulls are kept at Cambridge, and at Reading there are Guernseys as well. It seems clear that if a high grade of bull is to be kept and proper control of disease is to be maintained, the cost is likely to be of the order of 30*s*. per cow inseminated.

SYNTHETIC TEXTILE RESEARCH IN GERMANY

In June of last year (1942) orders were given in Germany that scientific workers there and in the occupied countries should confine their activities solely to research that would give immediate practical results. Assuming that there is any real validity in the oft-attempted distinction between fundamental or pure science research on one hand and the immediately useful on the other, it still remains a matter of considerable difficulty to predict whether or no a particular piece of research will yield immediately practical results. The question cannot be pursued here. The main point of interest is that, despite strict orders, the artificial textile research workers in Germany have just expressed their profound conviction that fundamental research, in that particular field at least, is of the utmost importance, and must be pursued, even under war conditions, with greater zeal than ever before. This was the dominating note of the fourth meeting of the Zellwolle- und Kunstseide-Ring at Weimar, and was emphasized by the Government representative himself, Staatsrat Dr. Schieber, in his opening address[1].

The Zellwolle- und Kunstseide-Ring was established a few years ago as a kind of study circle by the leading technical schools and universities in Germany, to the meetings of which leading specialists in the different branches of textile research are invited to read papers and initiate discussion. At this fourth meeting, in September last, it was claimed that much hitherto unpublished work of considerable interest was presented, especially in connexion with cell structure as revealed by the latest methods of electronic investigation.

This latter formed the subject of several papers, beginning with that of Dr. E. S. Schiebold, of the Leipzig school, on the use of the electron microscope for the study of organic molecules of the macromolecular type; followed by Dr. L. Wallner, also of Leipzig, on ultra-microscopic and X-ray work on cellulose structure; and by Dr. F. Gunther, on ultra-microscope studies of the polyamides and polystyrol. On the basis of numerous analyses and calculations of the kind described in these three papers, an attempt has been made to arrive at much more accurate and complete models of cell structure in natural and artificial fibres.

Problems of size, position, and spacing of the individual elements—molecules or molecular groups—especially in the softened or dissolved state, were discussed by Prof. Kratky, of the Kaiser Wilhelm

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[1] *Chemiker Zeitung*, 28, Oct. 1, 1942.

Institute for Physical Chemistry at Dahlem, who had used the so-called small-angle dispersion in his X-ray work.

Probably the greatest name, on the Continent at least, in macromolecular physics and chemistry is that of Dr. H. Staudinger of Freiburg i. Br., who recently completed his three hundredth paper on the subject. At Weimar, he reviewed his work on cellulose and introduced the results of his latest research on the relation between molecular chain-length and strength of fibre in the polyamide group. He referred also to the viscosity of dilute solutions of these products, a matter with which he had previously dealt in considerable detail, under the heading of molecule-colloids. Dr. F. H. Müller, of the University of Leipzig, dealt with specific viscosity in relation to structure in solutions; and Dr. Moll, of Berlin, discussed some differences between ordinary cotton and various artificial *Zellwollen*, and the effect of spinning methods, degree of polymerization, etc., using density measurements of the greatest accuracy. New methods of measuring these various factors were disclosed by Dr. A. Marschall, of the Zehlendorf textile factory, with special reference to the solubilities of various natural and artificial cellulose products.

Other papers dealt with longitudinal swelling of cellulose and *Zellwollen*; relation between degree of swelling and textile properties; treatment of cellulose with formaldehyde and other substances with a view to the introduction into the molecule complex of foreign materials and to so-called bridge-building for controlled modification of properties; and various methods of testing both artificial and natural fibres. No new fibres were introduced, with the exception of a new acetate silk by Dr. A. Sippel, of the Rhodiaseta Works at Freiburg, for which remarkable strength is claimed.

WELFARE OF WAR-WORKERS AND SEAMEN

A REPORT issued by the Ministry of Labour and National Service on "Welfare Outside the Factory and Seamen's Welfare in Port" (Cmd. 6411) gives some account of the work of the Welfare Department of the Ministry, August 1941–August 1942 (London: H.M. Stationery Office, 2*d*. net).

In regard to the transference of war workers to various parts of Great Britain, a 'convoy' system under which, for example, women coming from Scotland to the Midlands meet at Edinburgh or Glasgow and are then brought down in a party overnight in specially reserved compartments, accompanied by officers of the Ministry, and are met at Birmingham by the reception officers, has proved extremely successful. In regard to lodging and billeting, the formation of local advisory committees, including representatives of the local authority, regional officers of the Ministry of Health and Ministry of Labour and National Service, the women's voluntary services and employers and trade unions promises to give good results in difficult areas. Reference is again made to shopping difficulties, to problems of travel to and from work, and to the care of transferred workers during sickness, all of which are receiving attention, as are problems of recreation, entertainment and holidays, while to free mothers for war work, special steps have been taken to see that their children are cared for during working hours.

In regard to seamen's welfare, the provision of hostels has been a major task of the Department and such hostels have already been provided at Liverpool, Cardiff, Newcastle and Hull, while others are being established at Leith and Glasgow. These Merchant Navy Houses are managed by the National Service Hostels Corporation. Recreational centres with facilities for meals and a drink have been established at Newport and Hull, and others are being established at Swansea and Avonmouth. Health questions are also receiving attention, and the hospitals now make known to the seamen's welfare officer the names of all merchant seamen who have been admitted, to facilitate visiting and the supply of books, periodicals, etc.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk is open to the public.*)

Saturday, January 23

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, University College, Shakespeare Street, Nottingham), at 3 p.m.—Dr. R. A. Morton: "Vitamin-*A*".

Monday, January 25

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mrs. Reginald Wyndham: "Java, Sumatra, Celebes, Flores and Bali" (Kodachrome and other films).

Tuesday, January 26

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. M. J. Field: "Some Aspects of Indirect Rule".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir Lawrence Bragg, F.R.S.: "The Solid State", (i) "Atomic Architecture".*

Wednesday, January 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. S. Russell: "Trawling and the Stocks of Fish".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. K. S. Sandford: "The Geology of Northern French Africa".

Saturday, January 30—Sunday, January 31

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S.W.1). Conference on "Planning of Science, in War and in Peace" (to be opened by Sir Robert Watson-Watt, F.R.S.).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSICS AND MATHEMATICS at the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (January 29).

LECTURER IN ELECTRICAL ENGINEERING at the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (February 6).

CHAIR OF MINING—The Secretary, The University, Edmund Street, Birmingham, 3 (March 1).

SENIOR PHYSICS MASTER—The Headmaster, Ellesmere College, Ellesmere, Shropshire.

ASSISTANT HORTICULTURAL OFFICER—The Chief Executive Officer, War Agricultural Executive Committee, The Deanery, Worcester.

TEACHER (MAN OR WOMAN) OF MATHEMATICS, PLUS PHYSICS AND/OR CHEMISTRY—The Headmaster, The School, Dartington Hall, Totnes, Devon.

LABORATORY STEWARD for the Sierra Leone Government Medical Department—The Secretary, Overseas Manpower Committee (Ref. 624), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

UFAW: the Universities Federation for Animal Welfare. Sixteenth Annual Report, Year ending September 30, 1942. Pp. 4. (London: Universities Federation for Animal Welfare.) [71

Medical Research Council: Nerve Injuries Committee. Aids to the Investigation of Peripheral Nerve Injuries. (M.R.C. War Memorandum No. 7.) Pp. 48. (London: H.M. Stationery Office.) 2*s*. net. [81

University College of Science
PHYSICS Dep.
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NATURE

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THE STATE OF HEALTH IN EUROPE

THE smoke-clouds of war which shroud the war zones and the absence of health reports and of foreign medical journals make it difficult to form a scientific appreciation of health conditions on the Continent of Europe. At the same time, references in the Press of Germany as well as of occupied and neutral countries, and information supplied by neutrals who have visited Germany and the occupied countries, supply us to some extent with accounts which enable a general impression to be formed. As regards nutrition, the countries which are in a desperate plight are Poland, Jugo-Slavia, Greece and occupied Russia. The 'hungry countries' are Belgium, France and Norway. Czechoslovakia is considered to be a little better off.

The Poles receive a diet of 800 calories a day, which is about one fourth of the German ration; the Jews in Poland have 400 calories a day, that is, half the Polish ration; this is insufficient to maintain adequate nutrition. In the 'hungry countries', on paper the ration card is adequate; but in practice the inhabitants frequently cannot obtain their full ration. This is due not so much to shortage of food-stuffs as to inadequacy of transport, and the fact that the peasants, especially in France, distrust the war currency and keep their produce instead of taking it to market. In France, rationing was introduced much too late, and at a time when stocks of food-stuffs were largely exhausted.

In all the occupied countries deficiency diseases are now to be found—rickets, spontaneous fractures of bone, beriberi and pellagra. There is a deficiency of calcium shown by the lack of calcification of teeth. New diseases are said to occur; for example, epidemics of nephritis have been reported. Pregnant women are inadequately nourished, and it is alleged that a second pregnancy is tantamount to maternal suicide. There is a high increase in infantile mortality.

Germany, as she has already announced, will be the last country to starve. Here the ration card can be taken at its face value. The Army is very well fed; the diet is sometimes monotonous alike in quality and quantity. The workers are well looked after, and up to recently coupons have always been honoured. There is believed to be a 'black market', although the penalties are very heavy. Infant mortality has not increased. The children receive special nutritional care and are given supplies of vitamin C. The supply of milk to expectant mothers and children is regular and good. These mothers also receive a preparation of vitamin D through the district nurses. Margarine has been enriched with vitamins. The Germans' chief trouble is the so-called 'fat gap'. To cope with this they treat bones in an autoclave in order to extract the marrow. They also experiment in the synthesis of fats. One method is to oxidize paraffin and then to combine it with synthetic glycerin. Blood sausages are made on a large scale.

Before the War the Germans imported a large supply of soya beans from Manchuria. This has not been a great success, as the stocks became rancid.

Tuberculosis is a well-known index of a people's health and nutrition. At the end of 1941 the death-rate from tuberculosis was greatly raised in the occupied countries, and it has also risen in Germany, as in the War of 1914–18. Tuberculosis seems rife in Belgium. Generally, the increase noted in the disease is ascribed to various causes such as the breakdown of preventive measures, the return of war prisoners to France with 'open' tuberculosis, migration and under-nutrition. The number of primary infections seems to be increased and, owing to the lack of fuel, the restricted dietary is used by the body tissues of patients in sanatoria mainly for thermogenesis and energy production instead of combating tuberculous lesions.

Summer diarrhœa is again prevalent in the occupied countries.

Little accurate information can be obtained concerning epidemics, though from time to time reference is made to such outbreaks in the foreign Press. Recently it was stated that a severe epidemic of scarlet fever was raging in Denmark. In eastern Poland a virulent outbreak of tularæmia has been reported. This disease was previously unknown in Poland and seems to have been introduced from the U.S.S.R.

The chief epidemic bugbear is typhus. In Rumania there is little or no typhus, and the situation there appears to be well in hand. Polish prisoners of war, who might have conveyed the disease, were removed from the malarious area in the bend of the Danube to a healthier district, on public health grounds. Since the War, there has been much typhus in Poland, especially in the western region. In Warsaw and the Warsaw district there were some four thousand cases in 1940 as against thirty-three in 1938. There has been some typhus among German troops and in the front line. How much typhus has occurred in Germany it is impossible to say because the German figures do not include troops or residents in refugee camps. There has been no typhus in Hungary. Eighty-five cases are noted as occurring in a prison at Marseilles. The disease was imported from North Africa.

Every German soldier is inoculated with an omnibus vaccine in one administration. This contains an attenuated vaccine against typhus, an anti-typhoid vaccine (polyvalent) and a vaccine against dysentery. The inclusion of the latter vaccine seems of doubtful value. On the Continent a dead vaccine against typhus is chiefly used. The Germans are largely employing a brand prepared at the Pasteur Institute, Paris. There is a shortage of drugs, especially as regards anæsthetics, morphia and quinine.

The Allied Governments have announced that their first charge after the War will be to feed the inhabitants of the occupied countries, and they are making plans for this responsibility. If these countries are liberated gradually the task, obviously, will be much easier than if Germany collapses suddenly, as in 1918. A Continental expert considers that the chief demands will be for proteins, carbohydrates, yeast and ascorbic acid. The food should be supplied in as concentrated a form as possible in order to feed the greatest number. At first it will not be necessary to aim at an ideally balanced diet. Energy-providing foods will be the main requirement.

GEOLOGY, GEOLOGISTS AND THE WAR EFFORT

On various occasions apprehension has been expressed by British geologists at the haphazard use of them and of their science in the prosecution of the War. For example, the general unawareness of the services which geologists are able to render was dealt with by Prof. P. G. H. Boswell in his presidential address to the Geological Society in 1941. Later, Prof. H. H. Read discussed the position in an article in NATURE of January 10, 1942, and he has recently returned to the same topic in a talk, referred to below, to the Parliamentary and Scientific Committee. Further, in NATURE of March 14, 1942, the role of geologists in war-time was considered in a leading article, the concluding sentence of which was: "There must be more enlightened direction from above, to ensure that wherever geology impinges on human activity, in war or in peace, the contribution it can make is recognized without delay and appropriate action taken".

This advice, wherever else it may have borne fruit, appears to have fallen on stony ground, if we are to believe a Press report, at a "northern school of military engineers", where it is stated that a squad of water-diviners has been formed in the Royal Engineers. The information has most likely aroused nothing but a little pleasurable excitement among the general public who, as Prof. Boswell and Prof. Read both emphasized, are deplorably ignorant of geological matters. Unfortunately, however, this interesting item of British news was reproduced in the *New York Times* under the caption "Dowser Squad in Army—British to use Water-Divine s in the Middle East". Certain of the Americans, like most of the Russians, are more aware of the part to be played by geological knowledge in war, and this small news item will not tend to increase their estimate of British military efficiency.

The present position was summed up in a revealing reply given by Sir J. Grigg in the House of Commons on January 19, in answer to a question by Capt. Studholme as to what extent the War Office relies upon dowsers for advice on water supply. The reply is worth quoting in full: "The War Office does not rely on dowsers for advice on water supply in the United Kingdom, and so far as I know the only place where they have been tried is the Middle East. A report of their performance there showed a very small percentage of successes, and orders were issued that scientific geological methods only were to be used."

Total war implies the use of any and every means to beat the enemy. There are circumstances in which the employment of a squad of dowsers would be justifiable and proper to this end. Those circumstances would arise when no geologists were available or no geological information obtainable. Then in that dire hour, water-divining, witchcraft, magic or necromancy of any hue might be called upon both 'to amuse the troops' and to lend a degree of colourful camouflage to plain 'wild-catting'.

But these circumstances justifying the use of dowsers do not exist, for both geologists and geological information are in plentiful supply. It is known that a number of geologists are serving in many branches of the army, but not as geologists; among the members of the Canadian forces in Great Britain are geologists of experience, resource and skill. The staff of H.M. Geological Survey of Great Britain includes geologists completely conversant with every aspect of underground water-supply; many academic and professional geologists are available with a skill in the investigation of groundwater problems acquired in many years of consulting practice. A galaxy of geological talent is thus ready and eager to apply the resources of their science. We have, however, to record the melancholy fact that, so far as we know, two geologists are employed as such in the British Army. During the War of 1914–18, the number of geologists employed as such in the Forces was, by slow and painful steps, raised to five; the recent formation of the 'Dowser Squad' appears to indicate that there is still little appreciation in military circles of the services geologists can perform.

It is probable that these remarks will incite the wrath of water-diviners. It must here be explained that this present protest is more concerned with the non-employment of geologists, who are demonstrably equipped for the investigation of underground water, than with the employment of water-diviners, who are not demonstrably equipped with any certain powers in this direction. In this latter connexion, it is worth while to recall the tests of dowsers made at Guildford some thirty years ago. These tests are recorded in the *Sanitary Record and Municipal Engineering* of May 2, 1913, and were conducted by a committee of scientific men with the late William Whitaker, F.R.S., as chairman. Whitaker had no rival in his knowledge of the groundwater of south-east England. Three sites were chosen which gave a variety of known underground water conditions. One site had 20 ft. of gravel on clay and was traversed by a large sewer, the second formed the top of a service reservoir from which water was rapidly being run off, and the third was known to contain a hidden spring with a yield of about 50,000 gallons an hour. These conditions afforded an ideal test for water-diviners. Seven diviners were conducted over the sites and their findings recorded and compared. The descriptions of these would require too much space, but the conclusions of the Committee may be given. They are as follow:

"The general conclusions of the Committee on comparing the state of facts known to exist with the indications given by the diviners, are that whatever sensitiveness to underground water may exist in certain persons, of which some evidence has been given, it is not sufficiently definite and trustworthy to be of much practical value. Moreover, the lack of agreement with each other shows that it is more a matter of personal mentality than any direct influence of the water. The diviners as a rule confine their attention to small streams of water, and as there are few places where these cannot be found they may well show a large percentage of successes."

On the most charitable judgment, therefore, the powers of water-diviners are 'not proven'; on an ordinary judgment, they are "not . . . of much practical value". The formation of the 'Dowser Squad' of the Royal Engineers is an event which cannot commend itself to the scientific public. It is an event, too, which becomes inexplicable when it is recalled that an account of the uses of geology during the last War was published by the Royal Engineers themselves in a volume entitled "The Work of the Royal Engineers in the European War of 1914–1919: Geological Work on the Western Front" (Chatham: Secretary, Institution of Royal Engineers, 1922).

In the talk* to the Parliamentary and Scientific Committee to which reference has been made, Prof. Read makes a number of representations, among which is one inviting that Committee to press upon the War Office and other Service Departments the importance of the contributions that geology can make to the war effort. Prof. Read quotes Sidney Paige, senior geologist in the North Atlantic Division, U.S. Engineers, as saying: "Let thought be directed toward methods of supplying all possible relevant technical data, geological and otherwise, to those who have a particular engineering job to perform in the Army or out of it".

One of the difficulties in carrying out this sound advice is that unfortunately geologists alone appear to be qualified to decide the type of work for which geology is required. This restriction results fundamentally from the neglect of geological studies in the schools and universities, a neglect which forms the subject of another of Prof. Read's representations.

This difficulty just mentioned—that geologists know best when they should be employed—is among the topics considered by F. L. Aurin in a "Memorandum to Members of the National Service Committee of the American Association of Petroleum Geologists"†. In this memorandum, it is pointed out that engineering skill cannot be substituted for the geologist's knowledge of rocks. Aurin maintains that this has been repeatedly demonstrated in the United States and cites the case of the present road between Los Angeles and the San Joaquin Valley; the present route was indicated as the most feasible one by geologists about fifteen years ago, but for many years competent engineers struggled with construction and maintenance problems on an alternative route. He asserts that geologists should have worked ahead of the construction parties on the Alaskan Highway, and that geologists should be on other critical military roads such as any from India to China. Aurin's memorandum contains the following pertinent paragraphs:

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* Geology and Geologists in the War and the Peace. By Prof. H. H. Read. (Parliamentary and Scientific Committee, Courtfield House, London, S.W.7.)

† *Bull. Amer. Assoc. Petroleum Geol.*, 26, No. 7; July 1942.

> "Since the type of work to which geological skill will contribute can be determined only by a geologist, it is essential that there should be an organization in the Army comparable to that used in industry. No industrialist of experience would dream of attempting to make the decision of whether or not geologic work is desirable on a given project. He, therefore, establishes a chief geologist with adequate staff to advise him when and where and what type of work should be done and to recruit the essential personnel and assign it to its tasks. There should, therefore, be such a staff geologist so located that he will automatically learn of contemplated construction projects and of the areas where knowledge of the geology will contribute to the effectiveness of attack or defense. These men will then be able to advise that a certain number of geologists with certain qualifications are needed at this, or the other point."
>
> "Without some such mechanism as has been outlined, I see no hope that geology can be used as one of our special tools for winning the war. If such mechanism is provided, I have no doubt that it will contribute very substantially and that each geologist so employed will save men and materials for other effort and will, in special cases, contribute as only a highly trained specialist can contribute to our success."
>
> "In this war, as in no preceding war, we depend on science, and geology is a specialized branch of science for which there is no substitute."

It appears from this memorandum that the United States, in spite of its much better geological record, than that of Great Britain in the War of 1914–18 and of its considerable awareness of the importance of geology, still has not reached perfection in these matters.

The utilization of geology and other branches of scientific knowledge was the topic of the discussion which followed Prof. Read's talk, to which notes by various speakers are appended. There, for example, Mr. J. G. Bennett, of the British Coal Utilisation Research Association, considers that the technical information already available from the coal survey of Great Britain is not being exploited to the fullest possible extent. Dr. N. F. M. Henry regards geologists as themselves largely to blame since they have neglected to take active steps to ensure that geological knowledge is properly applied. More fundamentally, Mr. G. B. R. Pimm, of the Institution of Structural Engineers, considers the utilization of science and scientific workers by the Service Departments as part of a much larger question, namely, their proper use in the War, and the reconstruction and post-war periods. Mr. Pimm considers that this "can only be brought about by Regulations introduced by Organised Science, defining the place of Science in the service of the community, and the status, and rights and duties of all scientific bodies, particularly the Chartered Bodies already charged with the advancement of the various branches of Science".

These are broad and large matters following upon the consideration of the place of dowsers in the war effort, but the mobilization of the small 'Dowser Squad' is a symptom of a widespread disease.

J. J. THOMSON

The Life of Sir J. J. Thomson, O.M., sometime Master of Trinity College, Cambridge

By Lord Rayleigh. Pp. x+300+8 plates. (Cambridge: At the University Press, 1942.) 18*s*. net.

LORD RAYLEIGH has written a most excellent and satisfying account of the life of Sir Joseph Thomson. The book gives an adequate explanation of Thomson's epoch-making scientific work, and, in addition, a sympathetic and revealing description of his characteristics as a man.

Modern physical science is not an easy subject to expound to those who have no background of scientific knowledge. A choice has to be made between using elementary mathematics, and eschewing even the simplest equation in favour of a sometimes long circumlocution in words. In the preface, Lord Rayleigh makes it clear that he has chosen the latter course—"No formulæ have been used". Even so, eminent literary men have been heard to say they could not follow the scientific part of the book. Whether this is due to the difficulty of the author's task or to the deficiencies of a literary education must remain a matter of opinion.

Within the limits Lord Rayleigh lays down for himself, Thomson's work is well described, due emphasis being given to the more important results. The new physics may be said to have begun with Röntgen's discovery of the X-rays in 1895. The rays were found to make gases conductors of electricity, and Thomson and Rutherford carried out a joint investigation which showed that conducting particles are produced by the X-rays and that the particles can be made to carry a current if acted on by an electric force. By this process the charged particles are removed, as indeed they are if the conducting gas is left to itself. Thus there are likenesses and differences between conduction through gases and through liquids; both are due to the motion of charged particles or ions, but in conducting liquids the ions are always present, while in gases they have to be formed continually by an ionizing agency. On these lines an explanation of the phenomena of conduction through gases was given.

Thomson then turned to a study of cathode rays—the straight rays which proceed from the negative electrode when a current is passed through a gas at low pressure. Two views of their nature were held: most English physicists, following an original suggestion of Varley, thought that they consisted of a flight of negatively electrified particles, while a theory of waves was supported in Germany. The rays are deflected by a magnetic field, and, at an early date, Thomson, chiefly for this reason, took the corpuscular view. He measured the deflexion caused by a known magnetic field, and the kinetic energy of the rays by a thermo-couple, and thus found that the velocity was 15,000 km. a second and the ratio of mass to charge was 2×10^{-8} gm. per coulomb, to compare with 10^{-5} for the hydrogen ions in liquids, about a thousand times greater; thus in cathode rays either the charge must be larger or the mass smaller. In 1897 Thomson made the cautious statement: "these numbers seem to favour the hypothesis that the carriers of the charges are smaller than hydrogen atoms"—a momentous pronouncement which does not seem to have created much interest at the time; the chemical atom was too firmly established. Then he attacked the problem in another way. If the cathode ray stream consists of negative particles, it should be deflected by an electric field. Thomson therefore passed it between two parallel metal plates connected with the opposite poles of a battery, and, when the residual gas was very highly exhausted, got the deflexion. From this, he found a ratio of mass to charge agreeing approximately with his former result.

Much evidence was available to show that electricity, like matter, is atomic, the unit being that carried by the hydrogen ion in electrolysis. It was therefore increasingly probable that in cathode rays the mass was small, not the charge large. To confirm this result it was necessary to measure the charge directly, and this was accomplished by Thomson using a method based on the rate of fall of cloud drops condensed on gaseous ions, a method developed from work of C. T. R. Wilson and used by J. S. E. Townsend, who confirmed thereby that the charges were the same as those on liquid hydrogen ions. On these results, combined with Rutherford's on ionic velocity, Thomson found the charge on a single particle to be 2×10^{-19} coulomb, which confirmed the conclusion that the mass was much smaller than the hydrogen atom. Again, in order to measure both quantities on the same particles, Thomson used those projected from a metal plate exposed to ultra-violet light in a gas at very low pressure. The same result followed.

These infra-atomic particles were at first called corpuscles by Thomson, but they were soon identified with the electric units named electrons by Johnstone Stoney, a name also used by Larmor, Lorentz and others. After some years, Thomson himself adopted what had become the general usage.

This amazing discovery was J. J. Thomson's greatest contribution to physical science ; others had been working towards the result, but the chief credit goes to Thomson. His investigations opened a new epoch and led to the enormous developments of the last forty years.

Rayleigh points out that, after a comparatively quiescent period during 1901–6, Thomson gradually reached another peak, culminating, about 1912, with his work on positive rays, a fitting counterpart to his investigation on cathode or negative rays. Positive rays are much less easily deflected than negative ones, and are clearly ordinary atoms or molecules carrying electric charges. If the electrostatic and magnetic deflexions are arranged to be at right angles to each other, since one is inversely as the velocity and the other inversely as its square, a parabola is traced on a photographic plate, and if other charged atoms or molecules are present, each one produces its own parabola. For this work high vacua are needed, and the success was largely due to Dewar's method of absorption in charcoal cooled in liquid air. Thomson's most striking result was the discovery of two curves for the gas neon, indicating atomic weights of 20 and 22. Thus ordinary neon is a mixture of two bodies, named by Soddy isotopes. This discovery pointed the way to the great work of F. W. Aston, whereby so many elements have been shown to consist of isotopes.

Thomson was a great experimentalist, but he was not a skilful manipulator. He depended on others —especially his assistant, Everett—to handle his apparatus, though he was fertile in planning, and in suggestions when difficulties arose.

Science, moreover, owes to Thomson the creation of the Cavendish school of physics. When Cambridge in 1895 admitted as research students men from other universities, they flocked to the Cavendish Laboratory in ever-increasing numbers. Most of the prominent physicists in Great Britain and the Dominions, and many in the United States, received part or all of their training at Cambridge. Thomson's relations with the research students were most happy, and perhaps best seen at the annual Cavendish dinner, with songs composed for the occasion. Rayleigh singles out for special commendation one of which the chorus runs :

> "Here's a health to Professor J. J. !
> May he hunt ions for many a day,
> And take observations,
> And work out equations,
> And find the relations
> Which forces obey."

Lord Rayleigh justly praises also Thomson's moderately elementary lectures meant for undergraduates reading for Part I of the Natural Sciences Tripos. Rayleigh says, "I think I learnt more from these lectures than from any others I ever attended". Perhaps I may be allowed to echo those words.

From 1915 until 1920 Thomson was president of the Royal Society. For the first three years of the period the Society and many of its members were engaged on war work. Thomson himself served on the Board of Invention and Research under the chairmanship of Lord Fisher, for whom he acquired a great admiration.

In 1918 Thomson became Master of Trinity College. The appointment is in the gift of the Crown, and the Prime Minister (Mr. Lloyd George), after consulting Lord Balfour, recommended J. J. Thomson, knowing, he says in a letter to Lord Rayleigh, "his supereminence as a scientist". In his new post Thomson had to face duties and responsibilities unlike those to which he was accustomed. But his devotion to the welfare of the College, his interest in both its intellectual and its athletic achievements, were soon patent to all and won the appreciation of both fellows and undergraduates. As Lord Rayleigh says, he was readily accessible, never in a hurry, and always good-tempered, sometimes in rather trying situations.

Thomson died on August 30, 1940, and his ashes were laid in Westminster Abbey, near the graves of Newton, Darwin, Herschel, Kelvin and Rutherford.

Lord Rayleigh's book gives a worthy account of a great man of science. W. C. D. DAMPIER.

ATLANTIS REVISITED

An Unknown Land

By Viscount Samuel. Pp. 222. (London : George Allen and Unwin, Ltd., 1942.) 12*s*. 6*d*. net.

IT is no difficult task for a philosopher with some knowledge of science and some ideas for the regeneration of the human race to paint a picture of Utopia. What is difficult is to portray a Utopia in which the ordinary man or woman would care to live. Possibly W. S. Gilbert's gentle irony has all but achieved that feat, and suggestive as are many of the passages in this entertaining book, with one reservation, it is not the fascinating picture of scientific advance and social and intellectual development that remains most clearly in the memory after reading this book, but rather those passages in which, describing three of the States of the "Small Heads" who have separated in schism from the Utopia of the "Big Heads", Lord Samuel gently satirizes Russia, Germany and Great Britain. A competent journalist with real knowledge of science might have given as suggestive an account of the scientific advances of the Bensals, their achievements in agriculture, in industry, in fishery, in atomic energy, but in this long chapter on the Islands there is humour and humanity, and the philosophy which is the distinctive feature of Lord Samuel's essay in Utopia is warm as well as prescient.

Lord Samuel uses an old device to let his imagination and philosophic mind depict a people of reason and peace, detached from this disordered world, in the Southern Pacific where Bacon placed his "New Atlantis". Of Bacon's work this is indeed a continuation, though Salomon's House is no longer the one organization for scientific research as described by Bacon. It has been split up into several establishments in different places, though the Renfusa Institute at the capital town of that name is the lineal descendant of Salomon's House, and its central buildings on the same site are devoted to physics, astronomy and inorganic chemistry, with some of their applications in engineering and chemical industry. Biology has been transferred to an immense Institute elsewhere, and if neither biologists, physicists nor chemists can be expected to take Lord Samuel's account of Bensal achievements in research too seriously, that account should not be altogether rejected.

The chief defect of the book is indeed that Lord Samuel has poured too much detail into this receptacle of his full and inquiring mind. That may well obscure one of the dominant features of the book in contrast with Bacon's "New Atlantis". It is an essay on the reconciliation of philosophy, science and religion. With the new era which opened in Bensala with the introduction of suturization, the operation by which the Bensals delay the closing of the sutures of the skull and so give a longer period for the development of the brain, the inhabitants of Lord Samuel's Utopia turned from their concentration on material progress, with its achievements in mechanical invention, industrial chemistry and agricultural biology, to philosophy and religion. Here Lord Samuel develops not only a theory of education and a profound philosophy of "mental ambiency" but also the ideas of the 'sieve' into which the Bensals put all the ideas of the past and from which they extract the sensible "gist"—a kind of Napoleonic code of all knowledge and faith which assists the mind to discard its lumber.

Lord Samuel writes with his own charm and distinction, but does not disguise his debt to Butler and to Wells, no less than to Bacon. None the less, there is a certain unreality in this philosophical and ethical discussion. In banishing squalor and wretchedness and misfortune, the Bensals have banished also the human greatness of spirit which can triumph over tragedy and misfortune. The smug complacency of the Bensals is at times in almost revolting contrast with the heroism and fortitude with which thousands of men and women to-day are facing the tragedies and hardship of this War. It is difficult to believe that Lord Samuel anywhere in this volume touches the ultimate issues and values of human experience.

On a more practical plane, the pertinence of Lord Samuel's picture to present discussions on reconstruction is clear. By the device of inviting the Bensals to suggest the first steps to be taken if we were to accept as an ideal a system more or less like their own, he outlines a practical programme of reform. Also he delineates firmly and with prescience the problems that advancing mechanization and increasing leisure must set for us too, and on the road to reconstruction he sets the lights unmistakably at amber and green.

The contrast between the Bensal working week of nine hours, their custom of primary and secondary occupations, their elimination of purposeless occupations, may be in exaggerated contrast with conditions in Britain. That exaggeration, however, effectively points to the constructive thinking that must be done on the problem of leisure and on education for citizenship, before we can enjoy the advantages which mechanical advance has put in our hands without social disruption or disorganization in mass unemployment and mechanized amusement. This compressed mixture of science and philosophy, religion, politics and economics is not too indigestible to stimulate thought as to where mankind is going, and the moral values as well as the material standards which should be our guide. It may well have its place in provoking that new outlook and the receptive and creative minds through which alone there can emerge after this conflict a world order, warm with human life, safeguarded with humour, as well as enriched by the wise, ordered and co-operative use alike of the traditions and experience of the past and of the powers which science has put into our hands.

R. BRIGHTMAN.

BRITISH BIRDS

The Birds of Britain

By James Fisher. (Britain in Pictures Series.) Pp. 48+12 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1942.) 3*s*. 6*d*.

MR. FISHER'S "Birds of Britain" belongs to a series, Britain in Pictures, the distinctive features of which are (1) the beautiful illustrations, generally from work by leading artists; (2) the high standing of each author in the subject about which he writes. The book before us is no exception. Mr. Fisher is one of Britain's best young ornithologists. The illustrations in his new book have been chosen from the works of the best British artists and are represented by twelve coloured plates, beautifully reproduced, and twenty-six black and white drawings.

The author includes 424 different species of British birds, a list which is complete up to 1941. These are very usefully divided into nine sections: (1) residents (133); (2) residents now extinct (1); (3) summer visitors which breed in Britain (52); (4) summer visitors which have bred in the south (2); (5) winter visitors (26); (6) passage migrants (23); (7) scarce or irregular visitors, and vagrants (100); (8) birds which have been reliably recorded in Britain a dozen times or less, but more than once (61); (9) birds which have been reliably recorded only once in the British Isles (26). In his review, Mr. Fisher does not give a long list of the birds with descriptions useful only for reference purposes; most of his text makes fascinating reading. It is divided into sections: a bird's-eye view of Britain; peculiarity of British birds; historical changes; late changes; the observers; the future.

This book will prove to be a valuable acquisition to anyone interested in natural history.

THE NATIONAL GALLERY IN WAR-TIME

By F. IAN G. RAWLINS
Scientific Adviser to the Trustees

IT is one of the necessary sorrows of war that scientific workers are bound, for the most part, to apply their knowledge and skill for the time being to the work of destruction. It is also true, as is already obvious, that some good comes out of evil, but the primary aim is, and must be, to destroy. Naturally, there are heroic efforts to mend and to repair, perhaps even to restore; yet they are hard pressed to keep pace with the forces of obliteration. In this article, however, we are contemplating a happier theme, in which applied physics and kindred branches of technics have been harnessed deliberately and specifically to a project of conservation. Consideration of some such scheme is usually simplified a little by financial reasoning—the relative value of the things to be kept safe and the cost of doing so. But with the nation's heritage of pictures, in some respects the most precious and representative in the world, these terms become largely meaningless. It is the bare fact of irreplaceability which dominates thought. Loss or serious damage admits of no compensation. If science can help in this great quest for security, it will have shown that even in war its part is not wholly to undo. To save for posterity becomes an overwhelming urge.

Well before the outbreak of hostilities, the Board of Trustees of the National Gallery had approved plans for evacuation from the great building in Trafalgar Square, London. These were, in fact, implemented and the bulk of the collection was hundreds of miles away from London immediately before September 3, 1939. The programme of removal had been accomplished in ten days, in accordance with schedule. A tolerable exile had been arranged in various houses and halls. So far so good. Risks were reasonably spread. Administration and invigilation functioned duly. But was all this sufficient? Indiscriminate bombing all over Great Britain set in. Nowhere above ground was safe in the special sense applicable to unique and irreplaceable objects. Even the fire-risk assumed new proportions in some respects. Thus, inevitably, the question was raised whether deep shelter could not be found, and if it could, what new hazards and imponderables it would introduce. Here indeed was a task for science, to shoulder its full measure of responsibility. In the sequel, some indication may be seen of the course of events. Meanwhile, all the refuges above ground had fulfilled their purpose, providing safe shelter unimpaired until their supersession.

A Deep Shelter Policy

In a matter of days, as it turned out, the Gallery was committed in principle to seek a subterranean home. The prime need was to find it. Mines, quarries, tunnels, caves, even deep defiles capable of being artificially roofed and reinforced were visited and discussed. Seldom must such a search have been started, and more rarely still could one have been more disappointing in its opening stages. Site after site was rejected on grounds such as those of possible flooding, presence of noxious vapours, insecure roofs, difficult access, probability of becoming a target later on for indirect reasons, and so forth. Up to the time of writing, two of these locations are definitely known to have experienced incidents which, had they happened when in use as repositories, would have constituted in one case a major disaster, and in the other a potential threat too grave to have been disregarded. These facts are mentioned to demonstrate that sanctuary was not to be had merely for the asking.

Six precious weeks went by with nothing to show for them but negation. Then, almost by chance, the outlook changed. A site offering sufficient space to house the whole collection, and possessing between 200 ft. and 300 ft. of rock cover, appeared. The access was not easy, and it was obvious at once that fairly heavy works would be needed to make it suitable for the purpose. Nevertheless, it was possible. The natural temperature within was 47° F. and the relative humidity 95–100 per cent. Tradition locally had it that the temperature was unchanged throughout the year. No data in support of this were extant, and there was no time to begin extended observations. Instruments were put in position for a week as a rough guide. The temperature remained at 47°–48° F. and the relative humidity at a point approaching saturation. There was no alternative but to accept these figures as characteristic. A good record for freedom from falls of roof was produced (for this particular type of workings), and the risk of flooding could be taken as negligible. There were no noxious vapours, and the material present in bulk was chemically inert. There were other features too, not shared by most places of the kind, of a favourable nature. Beyond these broad considerations, nothing could be said with certainty. In addition to the increasing danger to the pictures in their quarters above ground, it became necessary for special reasons to make an immediate decision to accept or reject this place. In any event, some six to twelve months would elapse before it could be ready for occupation.

Within a matter of days, the Trustees, the Treasury and the Office of Works (now the Ministry of Works and Planning) had agreed to accept and to go ahead. It amounted almost to a venture of faith. The National Gallery thus became possessed of a repository offering cover against aerial attack to a degree approaching impregnability. Nothing but an earthquake could harm the contents mechanically. At the same time, due to the high relative humidity, ruin within a month might be expected for the pictures if this was not dealt with, and restrained, during the whole period of occupation. Furthermore, access was physically impossible for a large percentage of the collection. Thus, to begin with, matters were not easy. But the decision was clear-cut. The protective cover was ample, and the capacity for storage adequate. All the other troubles must in consequence be overcome.

Reviewing the situation at the present time, with the great collection safely housed, it may be stated that no major disadvantage was overlooked in that rapid decision. It was thought to be feasible to accomplish the task, and so in the event it has proved. Naturally, this is far from implying that there is little more to do. Life there, in some respects, resembles that of the crew of a ship at sea. Constant watch and ward was never more essential. There is much machinery, and full provision for emergencies. The pictures themselves need thorough-going inspec-

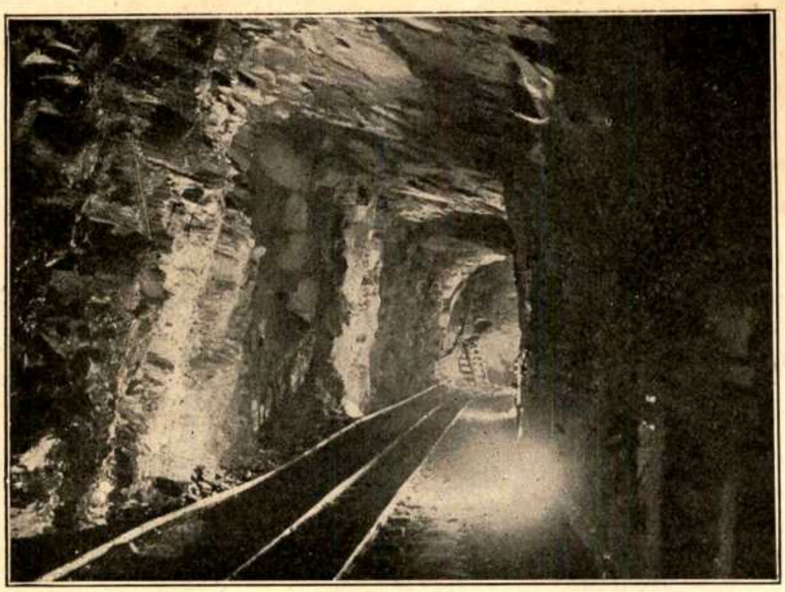

Fig. 1. THE MAIN UNDERGROUND APPROACH LEVEL. THIS WAS ORIGINALLY OF CROSS-SECTION 6 FT. × 6 FT. AND WAS ENLARGED TO 13 FT. 6 IN. HIGH AND 10 FT. WIDE.

tion at frequent intervals, if one is to be reasonably certain that all is well. Sometimes they need treatment, and this has been provided for. Temperatures, relative humidity, ventilation, electrical gear, the stability of the fabric, the workings themselves, all require ceaseless attention if accidents are to be avoided to within the limits of human fallibility. There is plenty of the unknown in this great bid for safety. From the beginning, the main responsibility for the safe-keeping and administration of the National Collection in exile has rested upon Mr. Martin Davies, to whom also is due much of the planning of its underground home.

In the next section, the arrangement of the repository and the apparatus installed will be described in some detail. Where information is lacking, the explanation is probably that data on that particular matter exist, but must be withheld at present for security reasons. When the time is appropriate more can doubtless be said.

The Underground Repository

The decision to place the great national collection below ground having been taken, the work of making the site suitable for the purpose devolved upon the (present) Ministry of Works and Planning. At this point a tribute of appreciation to the officers and staff of that department may be gratefully made, both for what has been done and for the way in which they have striven to meet the special requirements and ideas of the National Gallery. With a project so novel, it was only to be expected that some set-backs would occur; the isolated position and the season of the year in which operations began both had their share in making progress exceptionally difficult and arduous. When the full story of this aspect can be told in detail, it will probably be admitted that the period of preparation, though somewhat longer than anticipated, was not excessive. The managing director of the company working the site did all in his power to help in every way. The site was first seen on September 17, 1940. Four days later the decision to accept it was taken. Blasting operations started a few weeks later, and most of the buildings were ready for drying-out (but not for occupation) in May, 1941. By August, 1941, all essential engineering services had been completed and the buildings were ready to receive the pictures. The move in began on August 12, 1941.

The nature of the underground workings was such that the only reasonable way of securing proper temperature and humidity conditions (as well as due invigilation) was to erect separate buildings underground, and to 'condition' them individually. (By 'condition' is not meant full air-conditioning, as technically understood, but bringing physical conditions within each building to a state satisfactory for the contents, by the comparatively simple means to be described later.)

These buildings were designed to have no mechanical strength; they are simply 'envelopes' on a large scale. Of light brick construction and the inner walls and ceilings covered with wall-board, the floors are concrete, and the roofs are of fabricated material (treated with ruberoid) on top of which rests a wire-mesh mattress. The function of this is to distribute the weight, should any *small* fragments of rock fall from above. No provision is made against *heavy* falls of rock. This matter is one for constant expert vigilance on its own account, and upon it complete reliance

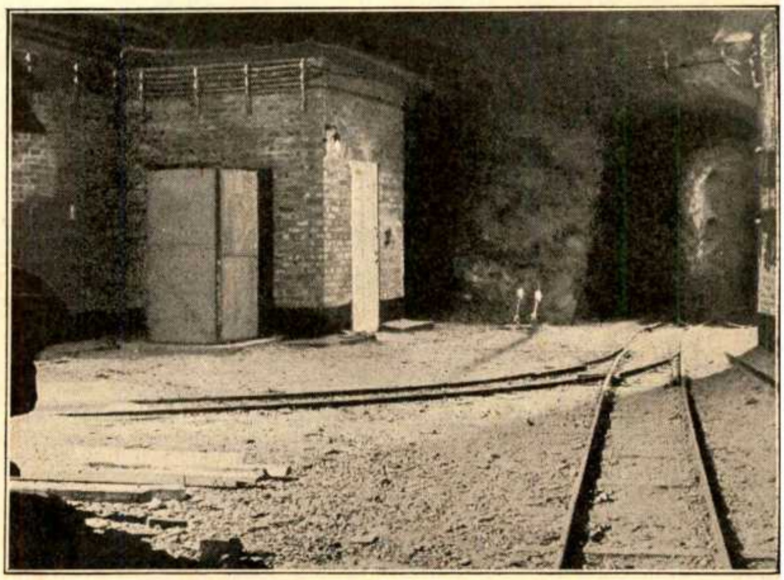

Fig. 2. A TYPICAL PLANT ROOM AND PART OF STORAGE BUILDING.

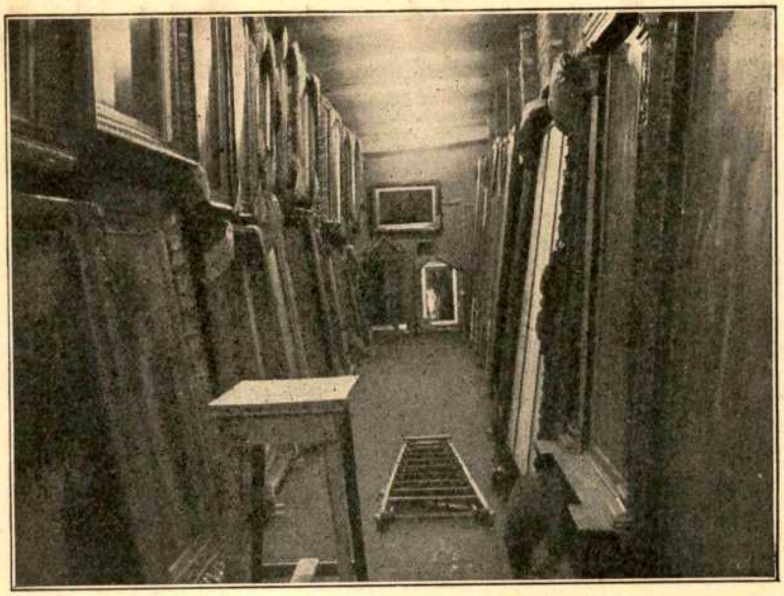

Fig. 4. INSIDE ONE OF THE STORAGE BUILDINGS, SHOWING PART OF AN AISLE, WITH PICTURES IN POSITION. THE HEIGHT IS 10 FT. FROM FLOOR TO CEILING.

has always been placed. Steps have been taken to ensure that all aspects of this possible hazard are kept under close review.

A question to be decided at the outset, which had a direct bearing upon lay-out, was the amount of wall-space needed, regarded particularly as a function of height. The guiding principle was that, in general, stacking of pictures was to be avoided. All were to be accessible for ready inspection. In this way, the problem was one of two dimensions rather than of three. The demand for height was such that ten feet would suffice for the great bulk of the collection, with fifteen feet for a small percentage of the total. In fine, this meant six buildings, five giving a headroom of 10 ft. inside, and one with a 15 ft. clearance.

These needs made somewhat rigorous demands upon the placing of the buildings, if maximum accommodation was to be secured. Thus, they vary considerably in shape and size. All except one are on a common level; the exception is approached by an easy flight of steps, and is reserved for pictures capable of being safely carried up by hand. Fortunately, there are many of a size suitable for this. The question was discussed at the outset whether any real advantage would be gained by having two-story chambers, where the natural height available permitted. This was answered negatively, both on the score of time and expense of making such buildings, and of the difficulty and dangers of taking pictures to and from the upper floor by stairs, lifts or cranes.

It may be mentioned here that the 15-ft. chamber already alluded to was designed to serve a double purpose. Its first duty was to act as the receiving and unpacking station. The vehicles containing the pictures, when they arrived, drove down a tunnel some 200 yd. in length, into this building, which is large enough to allow of turning and is provided with a suitable unloading dock and ramp. In fact, this building was planned in close co-operation with the railway companies who undertook the task of transport. The second purpose of the building was to house the largest pictures, and to act in some measure as an inspection shop for all the larger works. Thus, all unpacking took place in 'conditioned' surroundings. The overall size is solely governed by the amount of space available, but the inside dimensions were most carefully considered in the light of general experience in moving, storing, and inspecting pictures. A fair amount of room is needed for carrying, turning and so forth: to cramp this unduly would be to risk accidents. Almost every building is provided with a small work-room where such operations as laying blisters can be carried out. By these means it is rare that a picture has to leave its conditioned surroundings for treatment.

The plant-room contains the heating and ventilating machinery required for each building. One such plant-room and equipment suffices for each, except in two instances where shape and capacity necessitated the provision of two such plant-rooms.

The guiding principle in regard to the major problem of 'conditioning'—in the limited sense already explained—has been to make each building a separate self-contained unit which can be controlled individually as desired, so far as temperature and relative humidity are concerned. The advantages of this were found in the early stages of occupation, when the storages were gradually filling up with pictures (after a suitable

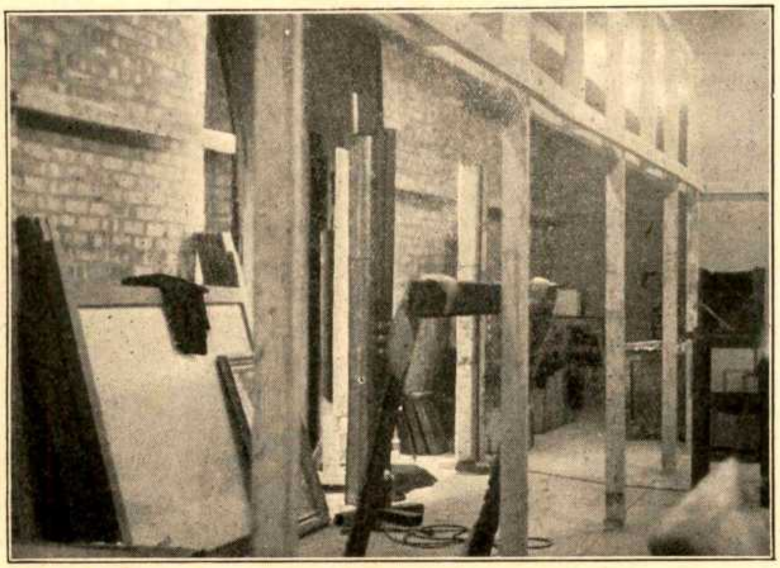

Fig. 3. PART OF A STORAGE CHAMBER BEFORE OCCUPATION, SHOWING STACK OF SCREENS (LEFT), READY TO BE FIXED BETWEEN THE UPRIGHTS IN CENTRE.

period of thorough drying-out, expedited by the use of refrigerating plant). Due to the concentration of so much hygroscopic material (wood and canvas), it is easier to obtain stable conditions when a building is full than when it is empty. In addition, certain other categories of valuable material are present, which need a physical environment of a slightly different kind. Again, when material first arrives, it can be gradually acclimatized to its new surroundings by the appropriate regulation of temperature in a certain building.

When the site was first explored, it had three factors of value from the physical and engineering aspects. These were: (1) a constant temperature so low as 47° F. inside the workings, as already mentioned; (2) easy access to electric power; (3) water, sufficient for engine cooling. In view of (1), it was considered that a satisfactory relative humidity in the buildings could be obtained by temperature-control alone, that is, there would be no need for a permanent de-humidifying plant. This relative humidity was provisionally fixed at 55–60 per cent at 62° F. It should be maintained constant to within 3 per cent. This is a narrow tolerance. The point is that once a relative humidity between 55 and 60 per cent—say 58 per cent—has been set up within a building fully occupied with pictures, then it is undesirable that fluctuations should lead to higher values than 61 per cent or lower values than 55 per cent. Owing to the impossibility of forecasting exactly what would happen with such an indefinite 'population' as a combination of panels and canvases, it was agreed to proceed on this basis. To anticipate for the moment: experience of a full year's working has shown that the plant gives, as an example, a relative humidity of 57 per cent at 64° F., with a variation in the former of less than 2 per cent over a period of many months. In general, the temperatures in the various buildings are some 2°–3° F. higher than anticipated, if the correct relative humidity is to be obtained. Of the two factors, relative humidity is decidedly the more important. The reason for this slight temperature excess, and an indication of the methods to be adopted to reduce it, will be considered later. The question of the influence of temperature upon mould growth has also been taken into account.

As already mentioned, each building has its own plant room or rooms containing the necessary fans for air distribution, heating batteries, dampers and automatic controls, the plant varying in output according to the requirements of each building. The essential equipment consists, in each plant, of an electrically driven fan drawing air through a suitable filter, delivering it over a heater battery into a simple plenum in the chambers.

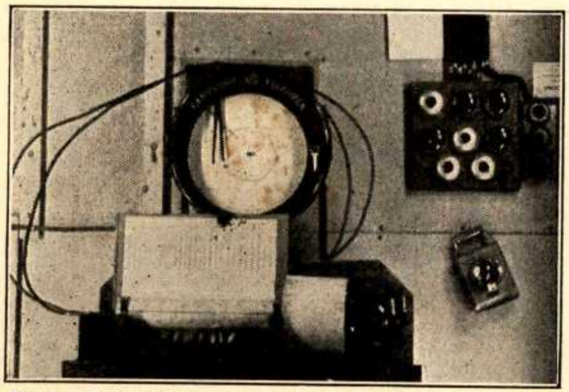

Fig. 5. HYGROMETER, CONSISTING OF DISC-TYPE TEMPERATURE RECORDER AND ASPIRATING SYSTEM.

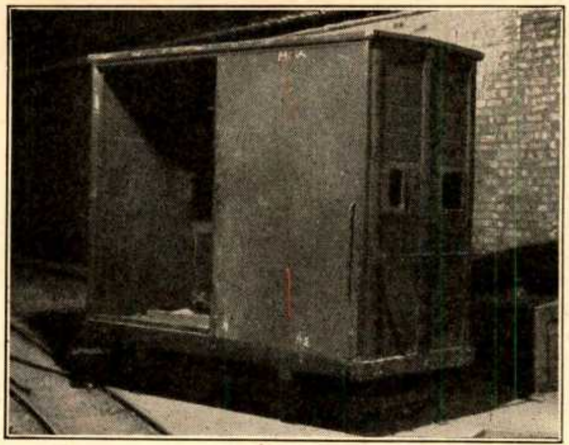

Fig. 6. CLOSED TROLLEY (ONE OF THE FOUR SIDE-DOORS REMOVED) FOR CONVEYANCE OF PICTURES BETWEEN VARIOUS STORAGE BUILDINGS.

Warm air is distributed as evenly as possible through ductwork having low-velocity outlets, and is controlled by louvre and slide-type dampers. Provision is made for partial or total re-circulation of the warmed air, and the proportion of fresh air introduced can be controlled. The unusually stable temperature conditions outside the buildings make thermostatic control as ordinarily understood unnecessary. Overriding high-temperature protection is provided and remote warning of a rise or fall in temperature exceeding 2° F. is given.

The only variable is that of electricity supply voltage at the terminal of a long and heavily loaded rural system, and this is compensated by hand adjustment of the calibrated louvre dampers, and by switching off sections of the heater batteries. This maintains conditions well within the differential limits of commercial thermostats and without the need for heavy voltage control equipment.

Normally, the system works on almost full recirculation of air, with a change of about four per hour. The operating cycle begins at the plant room, where a very small amount of fresh air at 47° F. and 95 per cent relative humidity is 'bled' into the system through intake louvres. The air passes into the filters, mixing with the recirculated air drawn from the chambers. Then it passes through the fan, across the heating battery, through the duct system and is delivered to the rooms through a series of suitably placed orifices. Then the air is drawn back to the plant room through 'recirculation openings' normally kept open. Excess fresh air drawn in at the plant room displaces a part of the stale air through 'evacuation valves' provided for the purpose. When fresh air is being drawn in and filtered there is always a slight outward pressure from the rooms which assists in preventing introduction of any dust from outside.

On occasions, staff is required to work inside the rooms and then the air can be freshened by opening fully the fresh air intake louvres, and closing the 'recirculation louvres'. Air escapes through the evacuation valves. For a given heat input, the temperature then tends to fall, and if the blow through is of long duration, the heat input must be increased.

The advantages of almost complete recirculation are a reduced power consumption for heating, and less heat loss to parts of the workings outside the buildings where the natural ventilation is sluggish.

There has been experience of local temperature rise to 52°–53° F. from 47° F. with decrease in thermodynamic efficiency, and to overcome the consequent rise of relative humidity in the rooms while maintaining temperature, it has been necessary to use calcium chloride as a pre-drying agent for fresh air entering certain plant rooms, and to install powerful fans to draw on the vast volume of air at 47° F. in other parts of the workings. At the worst, in one part, a maximum temperature of 66° F. has been necessary to maintain 58 per cent relative humidity. Energetic measures are being taken to introduce cool air to this locality, and shortly it is expected that it will be reduced to uniformity with the rest of the system.

The flexibility of the whole system is important. Certain valuable material needs individual treatment, and conditions in a building or part of a building can be readily adjusted without any widespread disturbance of conditions.

Throughout, it must be remembered that fungus and moulds constitute a formidable danger to pictures. Research shows that at such a modest figure as 68 per cent relative humidity, especially at temperatures of above 70° F., trouble may occur. Free circulation of air is an effective counter weapon. This is amply provided for in each building. A number of trial canvases and panels have been placed in various parts of the workings—outside the storage chambers—to observe what happens to them in air at around 47° F. and approximately saturated. Moulds were observed well within a month and, in one case, in eighteen days. Constant vigil is kept, not only on the pictures, but also on all incidental woodwork and fabric. Routine inspection is undertaken at short intervals.

The recording instruments in use are simple but essential. In every building there is a hygrometer of the type shown in the illustration. These consist of a standard double-pen disc type mercury-in-steel temperature recorder, adapted to work with an aspirating system composed of a couple of asbestos fibre tubes through which air is drawn by a small fan and motor. In one tube is the wet bulb, and in the other the dry. From the former, a suitable wick dips into a trough of distilled water. (The air-flow is at approximately the same rate as that generated by a psychrometer or whirling hygrometer.) From standard tables, and from the reading of the wet- and dry-bulb temperatures, the relative humidity in the chamber is known at any moment. Calibration with a psychrometer, as a check, is carried out at frequent intervals. These composite hygrometers have been found most satisfactory: a little difficulty was experienced initially in getting the exceptionally large amount of wick to saturate evenly and continuously, but this has been overcome. If the plants are stopped down for a couple of minutes, a decided knick is observed on the charts, thus giving confidence in rapid reaction.

Thermometers are placed at every recirculation louvre throughout the buildings, so that engineering staff can read them from the plant rooms on their patrols. A series of 'standard temperatures' have been worked out empirically, corresponding to the desired conditions within.

Outside the chambers, at various points in the workings, temperatures are recorded daily, to make sure that the ventilation remains satisfactory.

The possibility of electric power breakdowns and failures has been most carefully considered. On this account a 140 h.p. low-speed Diesel-alternator, capable of taking the whole load of motors, fans, heaters, lights and accessories, has been installed. Due to the isolated situation and the severity of local conditions, calls upon the emergency plant are not uncommon. Before the pictures were moved in, a stringent test was made, the generating plant maintaining the whole load continuously for a week. This was thought necessary in view of the reliance placed upon electric power to keep the relative humidity in the buildings from rising (within a matter of a few hours) to dangerous limits. Fortunately, circumstances are such that a more rapid deterioration is not to be expected, but there is not a great deal of margin in this respect. Almost equally important is the need for prompt—almost immediate—restoration of lighting after a breakdown. Experience has shown that it is never more than 2–3 minutes before the stand-by plant is running and normal conditions return. The double calamity of a failure of both electricity supply and stand-by plant at the same time has been envisaged, and super-emergency measures designed to mitigate such a situation so far as possible. There is, of course, staff on duty day and night. As mentioned before, an adequate (but not limitless) supply of water, capable of being treated for use in engine cooling, is at hand.

Indications have already been given of the somewhat heavy engineering works involved in this whole project. To conclude this section, some details may be of interest. Initially, the site (for the purpose in view) was practically without access. A new road, entailing some considerable excavations and embankment, was therefore constructed. Within the workings themselves, enlargement of adits and levels necessitated the blasting and removal of some 3,000 tons of rock (including work now in hand for the improvement of ventilation). In addition, a further 2,000 tons were removed by hand-labour from the floors before it was feasible to begin the erection of the storage buildings. In this enterprise a special appreciation must be made of the work of the local company's manager, under whose direct supervision these operations were all carried out. He discharged this task rapidly, and thanks to his knowledge of the local strata, without accident of any kind.

For the necessary transport of pictures and stores (including engineering equipment), the National Gallery needs about a quarter of a mile of underground narrow-gauge railway. The maximum gradient encountered is 1 in 20 for a few yards. Special rolling stock was built for it by one of the main-line railway companies. An example is shown in the illustrations. These trolleys (propelled by hand) have proved invaluable. In fact, it would have been impossible to have 'moved in' without them. Day in, day out, they are in regular use.

Future Problems

Large-scale research is scarcely practicable in a repository such as has been described, especially as the prime motive is that of conservation of the nation's great collection. Nevertheless, the future is not being left wholly to itself. A sizable body of data relating to temperature, relative humidity, condition and reaction of materials is being assembled, and may well take its place in contributing towards the post-war design of museums and galleries, and to the choice of environment considered best for works of art. It is possible that full air-conditioning of such institutions in large cities and certain other places might be found to be financially desirable, when the sums spent annually in restoration and repair of paintings are critically reviewed. Careful inspection will always be needed, but the experience so far of housing a collection of pictures below ground under controlled conditions, scientifically planned, is decidedly encouraging. It would be a pity if some of this could not be translated into terms appropriate to times of peace. Many great pictures are probably now going through severe hardships and many vicissitudes. Those for which the Trustees of the National Gallery are responsible, however, are at present enjoying a climate of such salubrity that the greatest problem for the future is to foresee how they will react when they leave it.

WILD BIRDS AND HOME-GROWN FOOD IN BRITAIN

By DR. WALTER E. COLLINGE

WRITING in NATURE in July 1918, I stated: "It behoves us to awaken and to take heed where we stand, or for some years to come our land will groan with the cry of desolation, due to our apathy and the ignorance and neglect of the ways and habits of our insectivorous birds, and the wanton destruction of what has ever been Nature's means of adjusting the complications of animal life, which man in his ignorance is seeking to pervert". In the quarter of a century which has since passed, the nation has lost millions of pounds worth of home-grown food.

For very many years past, I have given warning of the vital importance of framing a sound and logical policy relating to the protection and destruction of wild birds. To a very large extent this warning has fallen on deaf ears. Little or nothing has been done, the *laisser-faire* policy has been pursued, and at the present moment it looks as if Nemesis were about to overtake us. No useful purpose would be served by re-opening here the whole question. It is a difficult one, touching various interests and prejudices; but we must no longer shut our eyes to the various extremely dangerous suggestions that are being so widely circulated, and, I fear, in some cases being put into practice.

At the moment, the whole of Great Britain is deeply concerned in the production of the maximum amount of home-grown food and in being able to harvest it. In so far as it lies in the range of human endeavour, there must be no mistakes made that will lessen the harvest of 1943. We now know that big, clean crops of all kinds can be raised and harvested, provided they are kept free from pests and disease. Such pests as wireworms, leather-jackets and other soil-inhabiting insect larvæ exact an enormous toll on root and cereal crops. In a like manner, the larvæ of various moths and flies, and also aphids, take their toll of the fruit and other crops. The soil may be treated with various chemicals and the fruit trees sprayed, but both are only partial remedies and both processes are expensive and demand man-power.

Two primary facts stand out, namely: (1) Wherever the insectivorous birds of a district or districts are destroyed, either purposely or through climatic or other causes, there is an accompanying insect oscillation which is not reduced until the balance of bird life is restored. (2) In the case of certain insects the numbers of which remain relatively constant, the controlling influence is largely, if not entirely, due to the uniformity of the bird life from year to year.

Nearly sixty years ago, John Curtis told us that if the depredations of injurious insects could be brought under control "the benefit would exceed everything of which at present we have any conception". The amount of insect food that insectivorous birds will eat is very large. I have given the following as an illustration and in an endeavour to bring the fact home to the public. Assuming that there are 32,000,000 acres of land under cultivation in Great Britain and that we have a pair of birds to every four acres, these 16,000,000 would consume annually 135,411,328,000 insects, and these would be destroyed just at the season of the greatest agricultural activity and would be accomplished without any outlay of men or money. Yet it now seems that ill-informed people are advocating the destruction of rooks, gulls, blackbirds, thrushes and other insect-eating birds.

Very briefly, let us examine the facts concerning the few species of useful birds mentioned above.

Rook. During the past fifty years, this species has received more attention as regards its food habits than any other British species, and the general consensus of opinion is that this bird is economically of the very greatest value. The nature of its food has been shown to consist of large quantities of injurious insects and their larvæ, some of which are most difficult to destroy and which annually exact a huge toll on the produce of the land.

Sea-gulls. No more short-sighted policy than that of the destruction of sea-gulls has ever been promulgated, and if carried out will have results of a most devastating nature. We have at last given up the foolish idea that sea-birds generally feed only on fishes and therefore are impoverishing the supply. Nay, we have still further advanced, for we now realize that, so far as sea-gulls are concerned, the percentage of fish eaten is comparatively small, very small in some cases, and much of it is obtained from the garbage of the shore.

The black-headed gull—the bird that follows the plough—for the greater part of the year feeds upon injurious insects. The total percentage (stomach contents) for the year is 24·70, whereas the fish content is 3·73 per cent. The highest fish content for any month in the year was in November, with 12·85 per cent, whereas the percentage of injurious insects during April to October was 33·01, with the following figures respectively 32·96; 28·0; 37·30; 31·38; 38·83; 26·62; and 26·0.

"Of 664 specimens examined only 143 contained fish remains and 267 contained no marine organisms whatever."[1] For the common gull the figures were, injurious insects 14·66 per cent, fishes 5·16 per cent, and for the herring gull 9·52 per cent and 17·55 per cent respectively.

Blackbird. In 1924, I pointed out[2] that we had too large a resident population of blackbirds. From numerous observations made by myself and many correspondents, there was no doubt that the population seriously decreased during the winters of 1938–39 and 1939–40 (December to March) and investigations made during 1938 and 1939, when compared with similar ones made in 1933–34[3], showed that there was an increase in the percentage of injurious insects eaten from 22·0 to 30·5 per cent, and a slight increase in the percentage of slugs and snails. There was a striking decrease in the percentage of cultivated fruits and fruit pulp, which dropped from 25·5 per cent to 15·2 per cent. Complaints respecting this bird have been very few during the past few years.

Thrushes. The missel-thrush and the song-thrush are the only ones that concern us. Of the total food consumed in a year by the former, 30·5 per cent consists of injurious insects and 16·5 per cent of cultivated fruits. The figures for the song-thrush are 32·0 per cent and 15·0 per cent respectively.

Tits. Who it was who first accused the tits of being injurious I do not know, but I fully agree with Yarrell that "none can be more mistaken than these men". The great tit consumes 66·5 per cent of injurious insects per year and 3·6 per cent of fruit, while the blue tit takes 78·0 per cent of injurious insects and 6·0 per cent of fruit.

The above figures need no comment; their significance is patent to every thinking man and woman.

There are certainly a few injurious birds, chief among which are the starling, the house-sparrow and the wood-pigeon. Repressive measures for dealing with these are long overdue.

In 1921 I summed up my investigation[4] on the starling by stating that, failing some action as there outlined, "the agriculturist and fruit-grower will be left faced with a growing enemy which is devastating their crops and inimical to their interests, and the country with a portentous factor which is adding to the scarcity of home-grown food. In short, the starling has become a plague in the land and a source of great national loss". Observations made during the past eleven years fully bear out this statement.

It has been estimated that the house-sparrow occasions a monetary loss of £50,000,000 a year. Whether this amount is correct or not is of little matter. What we do know is that they consume a large amount of home-grown food, and if they were reduced to half of their present number, it follows that half of the huge total would be saved.

Before it is too late, it is necessary that the beneficial species I have mentioned above should be scheduled and the destruction of them or their eggs be prohibited. I feel certain if this were done now, even if only as a temporary measure, it would demonstrate once and for all what a powerful factor they are in ensuring prosperous agriculture.

Writing some little time ago I stated[5], "The 'man in the street' and others in high places may not have realized this, but nevertheless it is true, and unless we do realise the facts and take action our agriculture, forestry and all kindred arts are doomed. These are strong words, but only uttered after a life-time's acquaintance with the subject. . . . The Government and the whole of agricultural Great Britain are evading a great and vital problem of paramount importance to the nation and charged with its future existence."

Long ago the prophet Joel wrote, "Tell ye your children of it, and let your children tell their children. . . . That which the palmerworm hath left hath the locust eaten; and that which the locust hath left hath the cankerworm eaten; and that which the cankerworm hath left hath the caterpillar eaten. . . . The field is wasted, the land mourneth; for the corn is wasted. Be ashamed, O ye husbandmen, howl O ye vine-dressers for the wheat and for the barley; for the harvest of the field is perished."

Let us hope that we shall not have to give voice to similar words at the end of 1943.

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[1] "The Food of Some British Wild Birds" (1924-27), p. 254.

[2] *J. Min. Agric.*, 31, 182–186 (1924).

[3] *Ibis*, 610–613 (1941).

[4] *J. Min. Agric.*, 27, 1114–1121 (1921).

[5] *Nth. West. Nat.*, 15, 216–218 (1940).

THE ACADEMY OF SCIENCES OF THE U.S.S.R.

PROGRAMME FOR 1943

By ALEXANDER BAIKOV

Vice-President of the Academy

MORE than in any previous year, the plan of work for 1943 of the Academy of Sciences of the U.S.S.R. is designed to aid the Russian armed forces and war industries in securing a victorious termination of the War. Our main work will be directly concerned with improving armaments and therefore cannot be divulged; but it may safely be said that, if in the past year Soviet physicists, chemists and engineers did much to improve and increase the supply of materials, instruments and tools for war industries, in the New Year they will do considerably more.

Although the scientific effort of the country is almost entirely devoted to war needs, this does not mean that pure scientific research has been suspended. Russian mathematicians and physicists, for example, are continuing their investigations into the theory of numbers, the dynamics of the atmosphere, etc. However, the main effort this year will be focused on mobilizing the material resources of the country and increasing the supply of raw material for war industries. This work is under the direction of the Commission for the Mobilization of the Resources of the Urals, west Siberia and Kazakhstan, under the chairmanship of Vladimir Komarov (of the Academy), the Commission for Mobilization of the Resources of the Middle Volga and Kama Regions, and similar commissions which will make an all-round study of the problems involved. The plan of work of the Academy's geological and geographical department is devoted to exploration and study of new natural resources which may contribute to the country's defensive might, chiefly to the discovery of new deposits of manganese needed for manufacturing various alloys, aluminium, nickel, wolfram and other ores, as well as non-metallic minerals such as fireproof materials, for which there are now great industrial demands. Much work is also planned in locating new oil deposits and increasing the recovery in functioning oilfields. Great hopes are placed in the Volga-Bashkir expedition. Oil will also be searched for in the Permian Kama coal deposits of the Tatar Republic. As before, considerable attention will be paid to the secondary recovery of oil. Adequate coal supply is just now decisive for industry in the U.S.S.R., and Soviet men of science will make every effort to discover new deposits and help to increase the output from those already being exploited. The production of motor fuel from coal and shale of the Urals, Karaganda and the Far East occupies an important place in the plan of work.

Among eminent Soviet men of science who are engaged on the problem of mobilizing the country's natural resources, under the direction of Vladimir Komarov, president of the Academy of Sciences, are Alexander Fersman, Vladimir Obruchev, Alexander Skochinsky, Pavel Stepanov, Lev Shevyakov and Alexander Zavaritsky.

No less important a place in the Academy's plan is held by the problem of increasing the yield of cereal and industrial crops, such as rubber-bearing plants, cotton, sugarbeet, and potato; and also the manufacture of artificial fertilizers. The working out of new industrial processes and the intensification of existing processes constitute the central item in the plans of the Department of Technological Sciences of the Academy. Considerable attention will be devoted to the development of the power resources of the eastern regions of the country so as to ensure an adequate supply to the new industrial areas. Efforts will be made to improve industrial gas generating stations, and also to put the gasification of new forms of fuel on an industrial footing, utilizing sources available in various localities and thus obviating the necessity for long hauls of fuel. This will involve working out the principles of design of highly efficient gas-generating installations. The Department will also deal with problems connected with the economic restoration of the liberated regions.

In chemistry, work will be concentrated this year on industrial utilization of raw materials in the eastern regions, and the manufacture of synthetic rubber, plastics, pharmaceutical preparations, etc. The Institute of Chemical Physics will continue the study of the theory of combustion, which is of cardinal importance in the design of prime movers. Alexander Porai-Koshitz will direct researches into the utilization of the chemical products of coke in industrial plants of the eastern regions. Peter Kapitza will continue his work on the design of a powerful machine for making liquid oxygen.

The work of biologists will include investigations on the healing of wounds, and also on the prevention of infectious diseases. It is proposed to treat shock and tetanus on a wide scale by the method of Lina Stern, of the Academy of Sciences, which involves influencing nerve centres by spinal injections. Efforts will be made to discover more effective blood-clotting substances, stimulants, pain-relieving and fatigue-relieving substances.

Historians will engage on a number of interesting investigations, including the history of various nations—the Slavonic history of wars and international relations, the history of the second World War, the history of Russian culture and a chronicle of the present Soviet-German War will occupy chief place. The Department of Languages and Literature is compiling a work on language changes during the present War, a dictionary of modern Russian edited by Sergei Obnorsky, and a study of the mutual influence of Russian and English literature in the nineteenth and twentieth centuries.

The programme of work I have outlined was endorsed by the council of the Academy of Sciences at a meeting held in Moscow under the chairmanship of the president, Vladimir Komarov.

OBITUARIES

Prof. Arthur Willey, F.R.S.

Dr. Arthur Willey, emeritus professor of zoology in McGill University, Montreal, died on December 26. He was the son of the Rev. William Willey, a leading minister of the west of England. After education at Kingswood School, Bath, he proceeded to University College, London, where in his second year he worked in Lankester's research laboratory. After taking his degree he was sent to the Stazione Zoologica, Naples, where he did research on Tunicates and Amphioxus, afterwards returning to the College as fellow.

Amphioxus was reinvestigated by Willey from every aspect, as it was a key animal in the controversies on the ancestry of vertebrates. In opposition to Cuvier's four types of structure, Saint-Hilaire sought a unity of plan homologizing insects and vertebrates, Leydig especially comparing their brains. Kowalevsky followed in 1866 with researches on Amphioxus, but in 1875 Semper and Dohrn independently maintained an annelid ancestry for vertebrates. In the early nineties most schools of zoology seriously discussed all these views, but in 1894 Willey's book, "Amphioxus and the Ancestry of the Vertebrates", caused almost a revolution. He had tried his matter out in a course of lectures at University College, when he had insisted on his practical work including every stage in the development and structure of Amphioxus in comparison with Ammocœtes.

At this time the leading zoologists of Great Britain became excited about the Pearly Nautilus. This "pre-tertiary creation" had been re-examined by Graham Kerr, following on work by Ihering and Ray Lankester, and a knowledge of its embryology was desired. To this end the managers of the Cambridge Balfour Fund elected Willey their student and continued him for five years. Nautilus had first been described by the great Dutch naturalist Rumphius, together with many Malayan 'plant animals'. Owen was excited by the anatomy of a later specimen, but Cuvier did not live to see it in the flesh. Its shell had been known from the time of Aristotle, but it was always compared with that of the argonaut, which floats on the sea-surface in connexion with the development of its eggs. It was supposed to be related to Spirula, the soft parts of which were equally scarce, although its shell is common on tropical beaches. This form, however, has a floating life with a shell that has been reduced to a minimal weight and size and has become almost internal, whereas Nautilus is a ground feeder in comparatively deep water with an immense shell, the animal being in a terminal chamber out of which its crawling and feeding tentacles protrude; its flattened shell is held upright on the ground. Specimens which had floated to the surface, on which the early anatomy had been studied, were mostly moribund. Willey trapped specimens in relatively deep water; the bait was mashed-up crayfish wrapped in coconut fibre so as to be invisible to the animal, which proved to be attracted by smell, its pinhole eye not being the efficient eye of most cuttle fish. The necessary breeding for the embryology did not succeed with the means at Willey's disposal, but the anatomical account published in the "Zoological Results" of his expedition is classical.

The scene of Willey's first labours was in Blanche Bay, New Britain, now known as Rabaul. It is a circular rocky bay open to the east; a camp was pitched on an island erupted in 1878. The floor at 50 fm. and deeper was ridged by lava lines with deep chasms between, the feeding ground of Nautilus. A coconut plantation covered the low ground and was an oasis of civilization due to Parkinson, almost a 'king'. The island had been partially subdued by that warlike missionary, George Brown, but conditions were primitive in the extreme, the natives still in the stone age, and Willey was in constant danger, but at all times quite imperturbable. Here in the primitive native canoes with a 'boy' or two, he went out day by day, laying his baskets, hand trawling and sweeping his surface nets, returning to an open shelter and cooking his taro, breadfruit or yam with an occasional fish, a tunicate flavour often added from his experimental colonies. New Guinea, to which he went next, was even worse, the natives being flesh rather than fish eaters. It was alleviated by the purchase of a small sailing cutter. The D'Entrecasteau and Conflict Groups were visited and Willey was anchored off Buna for some time.

When sailing, one of the boys jumped overboard to secure a floating cuttle bone and off this, when placed in a pan of water, were secured quite a number of organisms, including some which could both crawl and swim. These proved to be Ctenoplana, a single specimen of which had been described in 1886. As it crawls it is a flatworm, and as it swims a ctenophore, transparent and provided with swimming plates. This important intermediate form, later worked out in Haswell's laboratory at Sydney, made up for many disappointments. There was also a lancelet, Asymmetron, previously caught only in the Bahamas but now known to be cosmopolitan.

New Guinea proving unsuitable for Nautilus, a move was made via New Caledonia to the Loyalty Islands in the New Hebrides, even then governed by a condominium between France and England. Off Noumea, an enteropneust, Ptycodera, was found; this with later specimens was the subject of a long memoir, a comparison with West Indian forms and Amphioxus. A settlement was finally made at Sandal Bay, Lifu, and here for eight months Willey tried to make his Nautilus breed, but its heavily yoked eggs were always infertile. The island population (7,000) were enjoying the everlasting Catholic v. Protestant fights, and so far as the French authorities were concerned there was, as usual, little generosity. Land as well as marine animals were collected and on these more than thirty memoirs were published in the "Zoological Results". Willey's special contribution among these was on a primitive beast from Rabaul, *Peripatus novæ-britanniæ*; this gave him great pleasure as he had an unbounded admiration for F. M. Balfour, whose classical memoir on *Peripatus capensis* he greatly admired. A further visit to New Britain terminated two years of field research.

On his return, Willey became lecturer in biology at Guy's Hospital, London, and he was shortly after elected to the Royal Society. He did not like this soul-killing job, and social conditions in England were to him unpleasant, while the climate was anathema. He was hence glad to go to Colombo as director of its Museum, a post he held from 1902 until 1910. Here in Ceylon he found a fauna little known except for Kelaart's Prodromus, 1892. He supposed he would find many animals peculiar to the island and a fauna comparable to the flora as described by Tennant and Trimen. He set out to examine the mammals but found no important forms not already known from southern India. The phenomena of endemicity were best represented in the reptiles, now being monographed by Deraniyagala. The fauna is analogous with those of Great Britain and Tasmania in relation to their neighbouring continents, but there proved to be relationship to the East Indies. Educational requirements were the subject of several reports, as also the sea and freshwater fisheries and various molluscs. The Museum began to take a scientific shape, no longer merely a collection of curiosities. It was an uphill job at first, the attitude of the ruling authorities being deplorable, while collectors seldom appreciated the necessity of accurate data. The *Spolia Zeylanica* was founded as a quarterly journal, since when zoology in Ceylon has never looked back. Willey's own researches wandered into the marine worms connected with the pearl banks. As an amusement he was collecting data for a book, "Convergence in Evolution", which at the time created great interest among students, stimulating the closer study of the living forms.

In 1911 Willey commenced his courses at the McGill University, where he remained for the rest of his life. From here he always wrote happily of his teaching and life in the University—and as an adopted son of Canada. He had a research interest which wandered into every side of animal life, plankton, placentation in the beaver, Branchioderma and Branchiotrema, general marine conditions, Arctic Copepoda and even a research on "Reductions and Reversions in the Wing Venation of the Stoneflies". He was called upon to advise on many economic sides, and Macallum paid high tribute to the value of his opinion. The University Club especially interested him, and with age he became less sensitive and retiring, while preserving a pleasant liveliness in disposition. He acquired a solid popularity, for he was always dependable. J. S. GARDINER.

Prof. F. M. Cornford, F.B.A.

PROF. F. M. CORNFORD, who died at Cambridge on January 2, at the age of sixty-eight, was the first occupant of the chair of ancient philosophy established there in 1931. He became a fellow of Trinity in 1899, and was a lecturer in classics until his election to a readership in 1927.

His published work was abundant and falls naturally into two periods, divided by the War of 1914–18 during which he served in the Ministry of Munitions. The earlier period is especially marked by an interest in the origins of Greek philosophy, and in the religious conceptions from which it developed. Thus the leading principle in "From Religion to Philosophy" (1912) is a distinction between the 'mystical' school, represented by Heraclitus, Pythagoras, Empedocles and Plato, a school which seeks primarily to preserve what the religious consciousness values, and a scientific school, including Anaxagoras, the Atomists and others, which tends to discard religion for rationalism. In "The Origin of Attic Comedy" (1914) he sought to explain the structure of the extant plays by examining the ritual forms which lie behind them; here he was influenced by the work of Jane Harrison and Frazer. An earlier work, "Thucydides Mythistoricus" (1907), was a daring re-interpretation of the historian's mental background and of the religious framework which governed the selection and presentation of his material.

It is no disparagement of these earlier and more speculative works to say that Cornford's most permanent achievement is to be found in the post-war books, "Plato's Theory of Knowledge", "Plato's Cosmology" and "Plato and Parmenides", in which he translated and interpreted four important Platonic dialogues. Departing from the ordinary form of commentary, he skilfully interwove translation with running comment in such a way as to produce books which can be read as continuous wholes. To readers with scientific interests the edition of the "Timæus" called "Plato's Cosmology" will probably appeal most strongly: it reveals perhaps most fully its author's many-sided knowledge and power of argument; few classical scholars could have dealt so successfully with the problems of astronomy and physics, physiology and medical theory which the "Timæus" presents.

Jointly with P. H. Wicksteed he translated Aristotle's "Physics" in the Loeb series, and the notes and summaries marked by his initial show how competent he was to interpret Aristotle's discussion of such fundamental concepts of science as time, space, movement and infinity. About a year ago his last book appeared, a translation of the "Republic", of which it can only be said here that it is more than a translation, and makes an excellent introduction to Plato for the 'unprofessional' reader.

Much important work of Cornford's is contained in periodicals, especially in the *Classical Quarterly*: it includes an examination of the Pythagorean number-doctrine, a paper on "Innumerable Worlds", and a new interpretation of Anaxagoras's theory of matter. Finally, his chapters on philosophy down to Aristotle in the "Cambridge Ancient History" can be warmly recommended to anyone wishing to make a first acquaintance with ancient thought.

R. HACKFORTH.

Sir Henry Maybury, G.B.E., K.C.M.G., C.B.

SIR HENRY MAYBURY, who died on January 7 at the age of seventy-eight, was a wholesome-looking, thick-set man with a capable headpiece, a general friendly attitude towards his fellows and a tendency to come to decisions to which he adhered with what admirers called his determination and critics his obstinacy. His first fame came when he was surveyor to the County of Kent (1903). That was about the time when a friend and I were organizing the Gordon Bennet motor race in Ireland. Its description by a jarvey illustrates the position: "Those parts of Oireland that's not consailed wid dust is covered wid people".

In circumstances like these, Maybury made his successful efforts in Kent to abate the intolerable dust which cursed the early days of the motor era. He courageously used tar-bound instead of water-bound macadam, and soon found he had achieved the great advance of making roads waterproof. He pushed forward with it with insistence, was hailed as a saviour by the owners of riparian property, and made Kent roads a model for the rest of the country.

Somewhere on Salisbury Plain a number of consecutive lengths of road all bearing the same traffic (that is, with no side junctions) and suitable for considerable speeds were prepared, each according to a different formula. The run being substantially free from bends and the surface level, it called for no stops, starts, accelerations, swerves or brakings. As these are the chief causes of road wear, no perceptible deterioration or wear by vehicles revealed itself. What did transpire was that the waterproofing with tar, bitumen or the like minimized what is a substantial source of road costs, even in unused roads, namely, land creepage, vegetation, weeds and, above all, deterioration by sun, rain and frost. The waterproofing would pay for itself in upkeep economy. Before long, water-bound macadam, gravel, and slippery roads made with chalky marl began to disappear.

Maybury was no researcher. His training as a railway engineer inclined him rather to the *ad hoc* experiment. Besides, the Harmondsworth Research Station for road materials to which so much of recent progress must be referred was not then in its stride. As chief engineer to the Road Board (1913) and later as chairman of the London and Home Counties Traffic Advisory Committee (from 1924) he accumulated much traffic experience. There came before him the noteworthy reports of the Metropolitan Police between 1920–27. They revealed year after year for seven years that high vehicle speeds occupied a far smaller place in the records of fatal accidents in town than did low speeds. Speeds not exceeding walking pace (less than 5 m.p.h.) were concerned in six times more deaths than were all speeds above 20 m.p.h. Moreover, a predominant majority (80 per cent) of fatal accidents occurred when the previous speed of the vehicles involved had been less than 15 m.p.h. On this Sir Henry Maybury's ripe experience led to the notable phrase often quoted from Report No. 61434–12: "A careful examination of these reports clearly indicates that there is an intimate connexion between the number of street accidents and traffic congestion". That was a new idea.

The moral is clear. Unfortunately for safe traffic flow afoot or awheel in Greater London, Sir Henry resigned in 1933, and now many of us sincerely deplore the final loss of his clear-sighted "obstinacy".

MERVYN O'GORMAN.

Prof. F. J. Allen

DR. FRANK JAMES ALLEN died on December 28 at Letchworth; he was born in Somerset in 1854. He went to Cambridge to study medicine and came under the influence of Michael Foster, and was one of the many physiologists who was inspired by that great teacher. He was awarded first-class honours in the Natural Sciences Tripos in 1878. He went to St. George's Hospital, London, where he studied clinical medicine, and later became an assistant medical registrar at that Hospital.

Sometime after qualifying in medicine, Allen returned to Cambridge as assistant demonstrator in physiology under Foster. He was elected a member of the Physiological Society in 1888, and later became a member of the Committee of that Society. He was appointed professor of physiology at Mason College, Birmingham, in 1888, and played a part in the negotiations which led to the formation of the University of Birmingham. He resigned his professorship in 1898 to enter general practice.

While in Birmingham, Prof. Allen gallantly captured a dog suffering from rabies and in doing so he was bitten by the animal. He went to the Pasteur Institute in Paris for treatment, and described his experiences as a patient at the Institute in the *Birmingham Medical Review* of 1898. The success of the treatment he received at the Institute is evident by the fact that he lived for a further forty-five years.

In his younger days, Allen made several contributions to physiological knowledge, and later devoted his spare time to a study of ecclesiastical architecture, publishing a book, "Great Church Towers of England", in 1932.

Allen was a widely read and cultured man, very modest and unaffected, and though many of his generation have passed away he is remembered by those who knew him with great affection.

H. P. GILDING.

WE regret to announce the following deaths:

Prof. A. K. Cajander, formerly professor of forestry in the University of Helsinki and director-general of the State Board of Forestry in Finland, who was Prime Minister of Finland during 1922–24 and 1938–39 and Minister of Defence during 1928–29, on January 21, aged sixty-three.

Capt. B. S. Cohen, formerly director of the Post Office Research Station at Dollis Hill, London, aged sixty-nine.

Prof. Edmund S. Conklin, formerly head of the Department of Psychology, University of Indiana, on October 6, aged fifty-eight.

Mr. A. H. Cornish-Bowden, for many years surveyor-general to the Government of the Union of South Africa, on December 5, aged seventy-one.

Prof. J. F. Craig, professor of veterinary pathology in the University of Liverpool.

Dr. Cyril Crossland, the first director of the Marine Biological Station at Ghardaqa, Gulf of Suez, on January 7, aged sixty-four.

Lord Hirst, honorary member of the Institution of Electrical Engineers, chairman of the General Electric Company, on January 23, aged seventy-nine.

Dr. A. L. Lowell, emeritus president of Harvard University, where his tenure of office, 1909–33, covered a critical period in university affairs, on January 6, aged eighty-six.

Dr. Alexander Russell, F.R.S., formerly principal of Faraday House, London, on January 14, aged eighty-one.

Prof. J. Strohl, professor of zoology and comparative anatomy in the University of Zurich.

NEWS and VIEWS

Science in the Service of Art

SIR KENNETH CLARK, director of the National Gallery, has sent the following notes referring to the article on "The National Gallery in War-time" by Mr. F. Ian G. Rawlins which appears on p. 123 of this issue. Mr. Rawlins has been scientific advisor to the National Gallery since 1934. To him the Gallery owes its admirable laboratory with X-ray, infra-red and ultra-violet ray apparatus, and equipment for microscope, tintometer and spectroscope work; and when the War began he was conducting important researches into the structure of pigments and the physical condition of old paintings. A few of his experiments in radiology are contained in the publication "From the National Gallery Laboratory", which was reviewed in NATURE of February 8, 1941, p. 165. In the years before the War, he was also closely concerned with the methods by which the pictures might be safely evacuated, and when finally it became desirable to place the whole collection in entirely bomb-proof subterranean vaults, he was responsible both for the discovery of a suitable site and for planning the equipment described in the accompanying article.

In the construction of the shelters and installation of plant, Mr. Rawlins worked in collaboration with the Ministry of Works engineers, and thanks to his foresight and attention to detail all the difficulties of this ambitious undertaking have been completely overcome. From the point of view of physical conditions, there is no doubt that the National Gallery pictures are better off than they have ever been or will be in the future. Mr. Rawlins's work did not cease when all the plant was installed and in working order. Constant vigilance is necessary to keep the perfect balance of temperature and humidity. In this work Mr. Rawlins has been ably assisted by Mr. Martin Davies, the member of the Gallery staff in charge of the depot, who has brought efficiency and unsparing devotion to the task of conserving the nation's pictures.

Polish Homage to Newton

THE Association of Polish Technicians in Great Britain held a special tercentenary celebration of Isaac Newton, under the chairmanship of Prof. Max Born, in the Mathematical Institute of the University of Edinburgh, on January 17. Addresses were delivered by Prof. E. T. Whittaker and Dr. S. Neumark, formerly *dozent* in aeronautics in the University of Warsaw, and now a flight lieutenant in the Polish Air Force. He was introduced by Major Chodacki, formerly High Commissioner for Danzig. Prof. Whittaker remarked that as the celebration had occurred in 1943, it had fallen in the same year as the quadricentenary of the death of Copernicus. Dr. Neumark, in his lecture in Polish, demonstrated Newton's decisive contribution in the development of natural science by means of a chronological diagram. This represented Newton as the central figure receiving the inheritance of the previous preparatory period, and extending his creative influence all over the world and over numerous fundamental branches of science. Newton's principal discoveries in the fields of mathematics, mechanics, astronomy, optics, aerodynamics, theory of heat and general foundations of natural science were described and illustrated by simple mnemonic diagrams. A rough classification of the whole of Newton's work showed that he made the incredible number of thirty discoveries of the first importance, each of which would have sufficed to confer permanent glory upon the discoverer. Newton's direct practical contributions to industry and to the progress of Britain were illustrated by his work at the Royal Mint, his remarkable steps towards developing mass production and his influence as president of the Royal Society. Dr. Neumark ended his lecture with a brief discussion of the unique problem which Newton's scientific personality offers to students of human creative power and genius. The linking of the centenaries of Newton and Copernicus is a happy prospective for the future relations between science in Britain and Poland.

Engineer or Physicist ?

ALTHOUGH the importance of physics in industry is now almost universally recognized, and the fairly obvious deduction that the application of physics to industry calls for the presence of physicists in the industrial team is beginning to be appreciated, the exact function of the physicist in the team is by no means generally agreed. There are still employers who are under the impression that every physicist is a potential Newton or Rutherford, and others who regard him as a sort of super-engineer, capable of providing an immediate remedy for all the day-to-day difficulties which crop up in the factory. Both classes are likely to suffer severe disappointment. It would, of course, be admirable if every engineer could be his own physicist, or every physicist a master of engineering. Unfortunately, both fields of knowledge are now so vast that this is no longer possible. Progress in industry demands the services of both engineer and physicist, and close and cordial co-operation between them. Cordiality is most likely to be maintained if each has his recognized sphere, and sticks to it.

The matter has recently been discussed by Dr. Percy Dunsheath in an article in *Engineering* (Dec. 11, p. 474). Dr. Dunsheath, who has, as one might say, a foot in both camps, is very well qualified for making a functional analysis of the situation, and his article will repay close study by all responsible for the direction of industry. The article is too long, and too closely knit, for abstraction. Dr. Dunsheath's conclusion is that the physicist's principal function in industry is to provide a liaison between the "continuous spate of new knowledge of the physical universe" and the factory, and so "translating it for early application". "The engineers," he concludes, "must all be physicists up to a point, but the physicist, so long as he carries physics to the utmost boundary of existing knowledge, need not be an engineer. . . . By fundamental research to collect and establish physical laws and the application of this systematized knowledge, the physicist can do much to refine industrial science which ultimately must be the practical work of the engineer."

The 'New Deal' as a Social Philosophy

AN exceptionally interesting interpretation of the origin and nature of the programme known as the New Deal in the United States is contributed by Prof. D. Mitrany to *Agenda* of October 1942. Prof. Mitrany insists that the whole philosophy and policy of the New Deal derives from the fact that the era of the physical frontier has closed and that the United States stands at the threshold of the social frontier. The New Deal is not a programme or an ideology conceived and propagated as a theory before it could be practised. It was set in motion by social necessity ; and a pragmatic attitude, a readiness to experiment, is characteristic of it as a whole, but was more marked during its first stage. The fact that the New Deal is a policy rather than a theory, and an improvised policy, makes it difficult to distil out of its action the social philosophy which inspires it. America's present social forces and trends have developed with the New Deal, and the crystallization of the new outlook has largely been stimulated by realization that the means for a full life were there, but that the old system had failed to make them available.

The measures of the New Deal fall in three broad but well-defined groups : in their effect on the mass of the people ; in their effect on the use of the nation's material resources ; and lastly, in their effect on government. For the mass of the people the New Deal has set out to provide security first, including protection against arbitrariness of economic wealth and power and gradual and continuous improvement afterwards. The activity of the New Deal for the salvage of the nation's material heritage makes an impressive programme, of which the Tennessee Valley Authority provides the outstanding example, as it does also of the changes which the New Deal is bringing about in the government of the United States. In establishing public control of the public use of those resources, the New Deal has broken sharply away from the old system, and the history of the Tennessee Valley Authority provides an illuminating epitome of the passage of public attitude from the 'old deal' to the New Deal and of the struggles that mark its progress. A great constitutional transformation has occurred without any formal changes in the constitution. The New Deal may be said to have brought about three essential changes in American outlook and policy : solicitude for the 'forgotten man' ; solicitude for the country's natural resources and technical equipment ; and a centralized public action for these two social purposes. The United States are passing from a social ideal of individual effort for individual reward to an ideal of mutual effort for common advancement, and Prof. Mitrany points out that the change involves a new outlook, a new method and a new purpose. The New Deal is still in its formative stage, but it is in essence a philosophy of social action. If its ends cannot be reached through international action, it may be thrown back during its next phase, as it was during the first phase, upon action of a national and socialistic kind.

Problems of Communal Feeding

MR. F. LE GROS CLARK has issued a broadsheet on "Soviet Forms in Communal Feeding". Coming as it does at a time when we are witnessing a rapid development of communal feeding in Great Britain, it is of very great interest and importance. Catering for people in large groups is not only economical in food, fuel and man-power, but also provides a good opportunity of improving the nutritional status of those fed. It is obvious from this study that the Soviet peoples are fully alive to both these aspects, and it is interesting to find that they came up against just those difficulties which are being encountered now in Great Britain. Needless to say, they dealt with them in their usual thorough manner. Our own tribulations might have been less had we taken advantage of their experiences. Thus, while we search for some means of preserving the palatability and the ascorbic acid content of meals cooked in kitchen depots and distributed in insulated containers, we read here that : "In 1931 the decision was taken to abandon completely the method of conveying cooked food in insulated containers and to utilise the depots almost entirely for the output of uncooked but partly prepared food of all kinds". In the same year, the wages of the kitchen staff were brought into line with those in other branches of industry. Mr. Bevin is struggling with this point now. Details are given of development, control, training of personnel, official standards to be achieved, 'special diets' sections, school canteens, rural canteens, etc. A study of them is heartily recommended.

Sylvicultural Research in Bengal

MOST of the provinces in India draw up a quinquennial programme of sylvicultural research work and prepare an annual report on the work undertaken in accordance with the programme. For this purpose a sylvicultural research officer is selected from the ranks of the Forest Department. The annual report on sylvicultural research in the Presidency of Bengal for 1940–41 (Government Press, Darjeeling, 1941) is by Mr. D. A. G. Davidson. In connexion with research in such an important branch of his work as sylviculture, which is its foundation, it appears that at a Divisional Forest Officers' Conference held in Darjeeling in 1940 a resolution was passed which reads, "the practice of allowing divisional officers to undertake research independently of the Sylvicultural Branch should be discontinued and no funds should be provided in future for divisional experiments". It is difficult to understand the meaning of, and the purpose underlying, this attempt at granting a monopoly to a research branch. In forestry, the opportunities for observation by the divisional officer, that is, the man who spends much of his time out in the forests in a definite locality which he can thus get to know with some intimacy—and in India this means large areas—are exceptionally advantageous. The officer may be every bit as observant as the research officer and has better, because more numerous, opportunities for carrying out a piece of research work up to a certain point.

The attempt to introduce exotic, faster-growing species in connexion with forestry has become a common habit in many parts of the world. Experiments in this connexion were commenced at Darjeeling and neighbourhood seventy and more years ago. The research officer is still engaged on these experiments. Attempts have also been made to induce seed production by ringing the trees, after the method practised for fruit trees. But most of the trees ringed in Bengal died. In experimental plots in the Chittagong Hill tracts, although the second story species, *Dichopsis polyantha*, *Artocarpus chaplasha* and other evergreen species regenerated profusely, the regeneration of the top species, Garjan (Dipterocarpus), has proved unsuccessful. It may be suggested that the Garjan might be added to the mixture by planting it in lines at 30–40 ft. apart and at such distance in the lines as may be decided, and that big plants should be used. This method has been found successful under somewhat similar conditions in West Africa.

Floatless Pump Control System

LONDEX, LTD., 207 Anerley Road, London, S.E.20, have introduced a patented system ("Lectralevel") of floatless liquid level control, designed for automatically pumping out, filling or maintaining the liquid level in a container and employing a single mercury switch for controlling the pump motor starter. The pump suction pipe may be earthed and used as one side of the control circuit, the pressure of which (25 v.) is derived from a small double-wound transformer supplied from the power or lighting mains. The control circuit is completed through the liquid to be pumped, and only light insulation is required for the electrodes, which may be of ordinary galvanized wrought iron tubing. A shorter electrode terminating at the highest level of the liquid is connected direct to the relay, and when the level rises to this electrode the relay is energized and the pump motor started. A longer electrode is immersed in the liquid to the lowest required level and is connected to the relay by the same lead through a resistance of a few ohms, its function being to pass sufficient current through the relay to hold the latter closed after the level has fallen below the short electrode. When the liquid level falls beyond the longer (lower) electrode, the relay circuit is interrupted and the pump motor automatically stops. The motor is not restarted until the level reaches the shorter (upper) electrode, when the aforementioned resistance becomes short-circuited and sufficient current flows to actuate the relay. The relay employed is the Londex *LQA*, the mercury switch of which carries up to 20 amp. at 440 v. Where the liquid is under pressure or insulated electrodes cannot be employed conveniently, a patented automatic liquid level control device of the induction type is available wherein a float is employed to alter the magnetic conditions in two coils which respectively operate the relays at high- and low-liquid levels.

Medical Services in Argentina

IN a recent paper (*Bol. Of. San. Panamer.*, 21, 955; 1942) on this subject, Dr. Hugo J. D'Amato, general secretary of the National Department of Hygiene, Buenos Aires, states that malaria exists in endemic form in northern Argentina and sporadically in the coastal zone. There was a considerable reduction in the number of cases in the endemic area in 1941 when the number of consultations was 193,000 as compared with 231,000 in 1940. More cases of goitre received attention in dispensaries in 1941 than in 1940, there being a high proportion of cases among school-children in the north. The campaign against venereal disease is being actively carried on, as is shown by the fact that the Public Health Department has secured supervision of 717 dispensaries, and serological analysis was being carried out in six cities in 1941. The law for prematrimonial examination is rigorously enforced with excellent results. During 1941, 389 new cases of leprosy were reported, making a total of 4,727, of whom 46 died. In November a colony of 700 beds was added to the existing four institutions under the supervision of the Public Health Department. The number of plague cases (52) in 1941 was a quarter of that for 1940. The following new health agencies have recently been established: a department of specific prophylaxis against diphtheria; a national committee of tuberculosis; a department of hydatidosis, and departments of plague and cancer control. Lastly, strict supervision of drugs has been established.

Public Health in Chile

NO epidemics have occurred in Chile since 1939 apart from some cases of typhus which were immediately controlled (*J. Amer. Med. Assoc.*, October 17). Good results have followed the control of malaria in the northern parts of the country. Although the mortality in early childhood is exceedingly high, much attention has lately been given to the feeding of mothers and infants, whose condition, it is expected, will soon improve. According to a new plan, 3,600 persons will have the right to ask for medical care under insurance as well as 200,000 or more children. Since 1940 the health of the people has been improved by providing rations in public restaurants to poor families free of charge.

Scientific Journal of the Royal College of Science

THE students of the Royal College of Science are to be congratulated on their success in maintaining the publication of their *Scientific Journal*, printing some of the papers read during the session 1941–2 before the Chemical, Natural History and Mathematical and Physical Societies. This volume, the third to be issued in war-time and the twelfth of the series, maintains the high standard and variety of scientific interest of the previous volumes. The range of subjects covers electron diffraction and the electron microscope, graphical and mechanical methods of calculation, the chemistry of hashish and of acetylene alcohols, methane as an engine fuel, the nature of viruses, and luminescence in Crustacea, as well as a historical paper on Arrhenius, Ostwald and van't Hoff. Copies may be bought from the Sales Manager, *Scientific Journal*, Imperial College Union, London, S.W.7 (paper cover 4*s*., bound 5*s*. 6*d*. per copy).

Introduction of Chinese Plants to Great Britain

FEW botanical explorers have surpassed the genius of Ernest Henry Wilson, who introduced the flora of China to Great Britain and North America. A short paper by E. H. M. Cox (*J. Roy. Hort. Soc.*, **67**, Pt. 11, November 1942) describes Wilson's expeditions to China, in the early years of this century, for the firm of James Veitch and Sons and later for the Arnold Arboretum. He visited the provinces of Hupeh and Zechwan, from which he introduced *Davidia involucrata*, *Meconopsis integrifolia* and a very large number of other species. Such well-known garden plants as *Buddleia variabilis magnifica*, *Clematis Armandii*, *Berberis Wilsonæ*, *Thalictrum dipterocarpum* and *Viburnum Davidii*, with several species of Rhododendron, Lilium and Abies, all owe their horticultural introduction to Wilson.

Earthquakes Registered in India during 1940

ACCORDING to seismological bulletins just received, numerous earthquakes were registered at the observatories of Agra, Bombay, Calcutta, Colombo, Dehra Dun, Hyderabad and Kodaikanal during the period July–December 1940 (*Seism. Bull.*, July–Sept. 1940 and Oct.–Dec. 1940. Delhi: Government of India Meteorological Dept.). At Agra, 66 were registered during the period July–September and 75 during the remainder of the year. Again, non-instrumental reports of earthquakes sensible to human beings are an important feature of the reports. During the first quarter under discussion, 16 were reported to J. M. Sil, meteorologist at Poona, the shocks of greatest intensity being of scale 8 (Rossi-Forel) and occurring on August 3 at Gulmarg, on August 8 at Gulmarg, on September 21 at the same place and also at Srinagar. During the second quarter, 11 earthquakes were reported as having been felt, the greatest intensity being 7 on the Rossi-Forel scale on two occasions. The first was at Bhuj on October 31, and the second at Srinagar on December 25.

The Night Sky in February

NEW moon occurs on February 4d. 23h. 29m. U.T. and full moon on February 20d. 05h. 45m. Conjunctions with the moon are as follows: Feb. 2d. 07h., Mars 5° S.; Feb. 3d. 15h., Mercury 0·4° N.; Feb. 6d. 10h., Venus 0·5° S.; Feb. 13d. 01h., Saturn 4° N.; Feb. 16d. 03h., Jupiter 4° N. Occultations of stars brighter than magnitude 6 are as follows: Feb. 12d. 19h. 24·7m., 179 B. Tauri (*D*); Feb. 13d. 19h. 05·6m., 318 B. Tauri (*D*); Feb. 24d. 05h. 00·3m., 65 Virginis (*R*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance, respectively.

There will be a total eclipse of the sun on February 4–5, invisible at Greenwich. The eclipse is visible in Japan, Alaska and the eastern parts of North America. There will be a partial eclipse of the moon on February 20, partly visible at Greenwich. The magnitude of the eclipse is 0·767. The circumstances of the eclipse are as follows:

Moon enters penumbra	....	Feb.	20d.	02h.	43·1m.
,, ,, umbra	....		20	04	03·0
Middle of eclipse	....		20	05	38·0
Moon leaves umbra	....		20	07	13·0
Moon leaves penumbra	....		20	08	32·4

Jupiter and Saturn are well placed for observation during the month. Mercury attains its greatest elongation west on Feb. 18, when it rises at 6h. 15m. in the latitude of Greenwich, about an hour before sunrise. Venus rises about an hour after the sun in the middle of the month and sets at 19h. Mars, in the constellation of Saggitarius, rises at 5h. 30m. about the middle of the month and is not well placed for observation. Comet Whipple is a naked-eye object and can be seen in the night or morning hours up to the time of sunrise. An ephemeris appeared in NATURE of Jan. 23, p. 106.

Announcements

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the James Alfred Ewing Medal for 1942 has been awarded to Dr. R. E. Stradling. The Ewing Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research.

THE Council of the Institute of Metals has awarded the Institute's Medal to Dr. Harold Moore, for "outstanding services to non-ferrous metallurgy". Dr. Moore has been director of the British Non-Ferrous Metals Research Association since 1932. Following his training under Dr. J. E. Stead, he held metallurgical posts with industrial firms before joining, as chief metallurgist, the Research Department, Woolwich, of which he was director of metallurgical research during 1919–32. The Institute's Medal, which is offered to the Council of the Institute by the Mond Nickel Company, Ltd., for award annually, is of platinum; previous recipients have been Sir William Bragg, Sir Harold Carpenter, Dr. Pau Merica, Dr. C. H. Desch and Sir W. Murray Morrison. It will be presented to Dr. H. Moore at the annua general meeting to be held in London on March 3.

To commemorate the birth, on March 3, 1843, of the distinguished metallurgist, Sir William Chandler Roberts-Austen, the Institution of Mechanical Engineers, the Iron and Steel Institute and the Institute o Metals have arranged a lecture on his life and work to be given by Dr. S. W. Smith, on Wednesday, March 3, at 5.30 p.m. at the Institution of Mechanica Engineers, Storey's Gate, S.W.1. Sir W. C. Roberts-Austen was an honorary member of the Institution of Mechanical Engineers and he conducted a notable series of researches for the Alloys Research Committee of that Institution; he was a past-president of the Iron and Steel Institute, and his name is perpetuated in the literature of ferrous metallurgy by the word 'austenite'. Dr. Smith, who in 1914 wrote a book "Roberts Austen; a Record of his Work", acted as Sir William's private assistant at the Royal Mint. No tickets are required for the lecture.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

X-Ray Evidence of the Nature of Cold Work in Metals

It is well known that the cold working of a ductile metal produces a broadening of its X-ray reflexions, but the physical nature of the changes that produce this broadening does not so far seem to have been satisfactorily established. The broadening may be due to small crystallite size or to the non-uniformity of the lattice parameter, and it is possible that both factors are present in actual practice. Different views, however, are expressed as to which is mainly responsible, and moreover there is a great deal of uncertainty about the real meaning of 'small crystallite size'.

It should be possible to distinguish between the two effects by means of X-rays, for they produce different variations of line-breadth with angle ; if β is the breadth of a reflexion with Bragg angle θ, $\beta\cot\theta$ should be constant for (isotropic) lattice-parameter variations, and $\beta\cos\theta$ should be constant for small (spherical) crystallite size. Dehlinger and Kochendörfer[1] have attempted to find which of these relations is obeyed in the case of rolled copper strip, and concluded that both effects were present ; their methods of estimating broadenings are, however, open to suspicion and their results cannot therefore be accepted unreservedly. Brindley[2] has used filings of various metals, and though he has not corrected his breadths for the broadening due to experimental conditions, he concluded that the non-uniformity of the lattice parameter is the more important effect. According to Wood[3], on the other hand, the main cause of the broadening is the small size of the fragments into which he considers the crystals to be broken by cold work ; but since his results are based mainly on one reflexion they afford no test.

Although filings are not the most suitable subject for experiment, since the stresses in them cannot be known and must certainly be heterogeneous, they form the most suitable kind of specimen for accurate X-ray work. We have therefore attempted to obtain complete evidence of the variation of line-breadth with angle by the methods devised by Jones[4]. Instead, however, of using a standard specimen of 'infinite' particle size, we have taken the photographs in a high-temperature camera of 19 cm. diameter[5], and the standard lines were assumed to be those from the specimen annealed *in situ* and recorded on a separate film. The method is unfortunately least accurate at the low angles, where the distinction between $\cot\theta$ and $\cos\theta$ is greatest ; errors of the order of 30 per cent are possible in the lowest reflexion, 111.

$h\ k\ l$	β uncorrected (mm.)	β corrected (mm.)	θ	$\beta\cos\theta$	$\beta\cot\theta$	E_{hkl} $\left(10^{12}.\ \frac{\text{dynes}}{\text{cm.}^2}\right)$	$E\beta\cot\theta$
1 1 1	0·64	0·18	21·7°	0·17	0·45	1·59	0·72
2 0 0	0·77	0·42	25·2°	0·38	0·89	0·78	0·69
2 2 0	0·84	0·44	37·1°	0·35	0·58	1·26	0·73
3 1 1	1·21	0·76	45·0°	0·54	0·76	1·02	0·78
2 2 2	1·01	0·47	47·6°	0·32	0·43	1·59	0·68
4 0 0	1·65	1·04	58·5°	0·54	0·63	0·78	0·49
3 3 1	2·18	1·24	68·2°	0·46	0·50	1·34	0·67
4 2 0	2·98	1·89	72·3°	0·57	0·60	1·03	0·62

The results for a specimen of copper filings are shown in the accompanying table. The specimen was annealed at 400° C. for 30 minutes to give the standard lines. It will be seen that, although there is a large scatter, $\beta\cot\theta$ has much less systematic variation than $\beta\cos\theta$, which indicates that the broadening is due mainly to lattice parameter variation and not to small particle size. It appears that broadening due to the latter effect, if it exists, is masked by the former.

Whatever the nature of the distortion produced by cold work, it is to be expected that local internal strains will be produced varying between zero and the maximum possible. The maximum possible lattice strain can be calculated from the yield stress Y and the Young's modulus E, and, as shown by van Arkel[6], it agrees well with that observed. From the breadths of the lines in the present case, $Y = \frac{E\beta\cot\theta}{4R} \sim 2 \times 10^9$ dynes/cm.^{2} (where R is the radius of the camera), and the generally accepted value for copper is $1 - 2 \times 10^9$ dynes/cm.^{2}.

Since E varies with direction, we might expect that the breadths of the X-ray reflexions would also vary with direction. The product $E\beta\cot\theta$ should be constant if the maximum stress is independent of direction, and it will be seen that in this quantity, shown in the last column of the table, the scatter of values is much less than for $\beta\cot\theta$ alone. Only one line, (400), is in bad agreement, but this is the weakest line on the film.

Further experiments are in progress. It seems that X-ray methods throw a great deal of light on the mechanism of cold work, but it must be emphasized that the observation of *all* the spectra is necessary if the utmost information is to be obtained.

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Ionization in Hydrogen by Fast Hydrogen Neutrals

Recent work by Varney and his collaborators[1,2,3], also earlier work by Beeck[4], have shown that gases can be ionized by their own accelerated neutral molecules or atoms. A classical theoretical treatment of the problem was given by Zwicky[5], who showed that the effect is most likely to occur when both reacting particles are of equal mass. It was first noticed with the inert gases, particularly argon, for which the effect is relatively large. Berry[3] has very recently published results obtained with hydrogen in the type of apparatus developed by Varney's school, in which a velocity selector is used for the positive ions. The latter are neutralized in a separate chamber and then pass into the space-charge detector[6,7], where they are detected after causing ionization. The strength of the remaining neutral beam was assessed by measuring the secondary electron emission from a target by which it was struck. The voltage range for the neutral particles was approximately 900–6,400, and the cross-sections ($N_1\sigma$) per cm.^{3} of gas at 1 mm. mercury pressure were approximately 2(A), 0·05 (He), 0·15 (H_2) and 0·9 (N_2).

I carried out some experiments with a canal-ray positive ion source in 1939[8], using hydrogen (99·3–99·7 per cent, with about 0·7–0·3 per cent oxygen), and which seem to be of interest in view of the above work. The canal ray beam (several hundred microamperes of 20 kV. H_2^+ and H_1^+ ions in approximately equal proportions) passed from the source (about 0·1 mm. mercury pressure), through a canal 2·1 mm. long and 1·5 mm. in diameter, into a region where the pressure was about 5×10^{-4} mm. mercury. The positive ion beam was deflected electrostatically and it was found, as expected from previous work, that a large proportion (about 75 per cent) of the beam, judged by the luminosity in the gas, was composed of neutral particles. The effective strength of the neutral beam was probably several hundred microamperes, and may have reached about 1 milliamp., because, in other experiments, secondary electron currents from various electrodes indicating the possibility of such a beam strength had been measured[9]. A double Faraday cylinder placed to measure the undeflected positive ion beam showed that when the voltage was applied to the deflexion plates, a positive current of about 4 microamp. was indicated. When the source was switched off, leaving the gas flow unaltered, the current always fell to zero, showing the absence of spurious discharges in the deflexion chamber. The main beam was about 18 microamp. in this particular experiment, measured with a small receiving aperture at 50 cm. from the canal, where the strongly divergent beam had, as stated above, a strength of several hundred microamperes. The deflecting field was more than ten times greater than that required to deflect the beam off the collector aperture. On one occasion, 50 kV. was applied to the deflector plates, whereas about 800 volts was sufficient to give adequate deflexion from the collector. Indeed, it is likely that such strong deflecting fields reduce the current of ions to the collector.

It was considered that the residual current might be due either (*a*) to liberation of electrons from the collecting cylinder, or (*b*) to the collection of positive ions produced in the gas by the action of the fast neutrals, if it is reasonable to suppose that such positive ions would tend to be 'knocked-on'. The reaction is:

$$X^{\text{fast}} + X \rightarrow X^{+\text{fast}} + X^{\text{slow}} + e^{-}.$$

Hence the effect was considered comparable in some respects to the well-known *Umladung* reaction

$$X^{+\,\text{slow}} + X^{\text{fast}} \rightarrow X^{+\,\text{fast}} + X^{\text{slow}}.$$

Excitation was also present in the gas, because the neutral beam luminesced (hydrogen red). Case (*a*) was considered unlikely, as the Faraday cylinder was always used in such a way as to eliminate secondary emission effects so far as possible. It was also considered that such emission from the collector could be caused either by reception of fast neutrals or by photons in the gas, although the canal ray spectrum was stated[10] to consist largely of the lines at 4,340, 4,863 and 6,563 A. Further evidence for the absence of secondary emission from the collector was available in that wide variations (1–20 kV.) in the voltage applied to the live (positive) deflector plate had no effect on the magnitude of the residual current. The latter would have been expected to rise with increasing positive deflector plate voltage if the secondary emission from the collector had been taking place. The live plate was made positive to eliminate the effect of secondary emission from it to the earthed vacuum chamber and Faraday cylinder, which was nearly at earth potential. The deflector plates were struck by large stray currents from the canal ray beam.

Thus it seems almost certain, although I wish to emphasize the approximate nature of the results and the fact that no further attempts were made to elucidate the phenomena, that the residual current was due to ionization by fast neutrals, as photoionization in the gas did not seem likely to account for it. Such effects, if present, may also occur in Varney's work. My experiments, described briefly above, were incidental to the main purpose of the work, which was to produce an intense canal-ray beam. However, with the approximate values of pressure, initial neutral beam strength (1 milliamp.) and collected current, the calculated cross-section is of the order given by Berry[3].

In conclusion, it is possible that the copious beams of fast neutrals formed by canal ray sources may be of interest in experimental work of the kind conducted by Varney, who used accelerated electrons from a hot filament to produce the primary positive ions.

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[7] Varney, R. N., *Phys. Rev.*, **53**, 732 (1938).

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Nature of Entropy

To the student of thermodynamics, the conception of entropy usually presents some difficulty. It seems to have no precise physical significance, but is often regarded as no more than a mathematical convention. This can only be due to inadequacy of our thermodynamic theory, since a quantity which fits so completely into the mathematics of the subject must surely have some relation to the physical facts.

The definition of entropy according to the equation $d\varphi = \frac{dQ}{T}$ suggests that it may be regarded as occupying in thermodynamics theory a position somewhat analogous to that of momentum in mechanics, or of coulombs in electrical theory, temperature being analogous to velocity or to electrical potential difference. There ought, in fact, to be such an analogy because, according to the kinetic theory of gases, temperature is proportional to the mean kinetic energy of the molecules; but the analogy fails because of the square law relationship between kinetic energy and velocity, between electrical energy and electrical potential.

Although this, by itself, may seem a flimsy pretext, the suggestion arises that our scale of temperature might with advantage be re-designed so that heat energy should become proportional to the square of temperature. The selection of a scale of temperature based upon equal increments of energy and incidentally equal divisions of a thermometer scale appears to have been rather arbitrary, and is no doubt due to the limited variety of manifestations of heat that can be measured in preconceived terms. In fact, all heat measurements come back to temperature, and that cannot be measured absolutely. It is conceivable that, had we lacked means of measuring velocity directly, we might have evolved a scale of velocity based upon equal increments of kinetic energy.

If, for greater mathematical convenience, we remade our scale of temperature so that temperature became proportional to the square root of heat energy, and, in the kinetic theory, to the mean molecular velocity, then subject to adjustments in the definition of specific heat, the position of entropy would be more clear. Entropy would, in a simple heat transfer, bear a straight-line relationship to temperature, mean molecular velocity would be proportional to temperature, and equal increments of temperature would represent a greater increment of energy at high temperatures than at low. In this and other respects, the theory of thermodynamics would conform more closely to the kinetic theory of gases and would acquire a helpful similarity with mechanical and electrical theories with their basic and, to all intents and purposes, identical energy expressions: $\frac{1}{2}mv^2$ and $\frac{1}{2}CV^2$.

I am not a physicist and do not know the full extent or effect of this tentative suggestion. Einstein said in 1921, "I am convinced that philosophers have had a harmful effect upon the progress of scientific thinking in removing certain fundamental concepts from the domain of empiricism . . . to the intangible heights of the *a priori*".

Is it possible that this is a case in point ?

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Reclamation of Bracken-land

IN the course of work on the improvement of rough pasture and moorland, to be published shortly, some attention had to be given to the reclamation of bracken-land. The site (a hillside of the Vardre near the ruins of Deganwy Castle, North Wales) was thickly covered with bracken about 2 ft. in height, free from undergrowth, the soil being sandy to light loam. The following treatment led to satisfactory results.

Late in autumn, the bracken was cut and left spread out on the ground, and a dressing of calcium cyanamide (10 lb. per rod) and manganous sulphate (4 oz. per rod) was applied. Within a few days the vegetation turned blue and gradually withered. In the following March the plot appeared bare, the disintegrated bracken having been embodied in the turfy soil and forming a spongy surface, which readily retained moisture. A mixture of grass seeds, including red and white clover, trefoil, timothy, rye grasses, cocksfoot, tall oat, meadow fescue, crested dogstail, and smooth meadow grass (4 oz. per rod), soil from a pea cultivation (1 lb. per rod) and sand was scattered on to the slimy surface. By the end of June the plot was covered with a fine crop of meadow grass including legumes, the vigorous growth continuing late into autumn. During the next summer the grasses were found well established and free from bracken. Although rational husbandry, such as the addition of phosphorus and potassium, the introduction of grazing cattle and the elimination of bracken in the neighbourhood would have in all probability ensured further improvement and permanency, the plot left unattended amidst an area of bracken gradually receded, and within six years gave all indications of reverting to its original condition.

Here we have calcium cyanamide and its degradation products functioning as an all-embracing parasiticide (cyanogen, urea), humifying agent (ammonia), long- and short-term fertilizer (lime, nitrates), growth promoter (urea)[1], and *p*H regulator (calcium, dicyanodiamide). The humification of all available organic matter, including the bracken rhizomes, is in reality a reproduction of the compost process *in situ*, differing, however, from the Indore method by the preponderance of chemical over biological reactions. The seasonal separation of the destructive from the nutrient phases of calcium cyanamide was attained by increasing its quantity[2] and regulating the time of its application. The manganous sulphate catalyses the oxidation of ammonia to nitrate independently or in conjunction with the nitrifying bacteria[3], reactivated after a lapse of four months. The addition of soil from a pea cultivation, as an inoculation, introduces nitrogen-fixing bacteria essential to the legumes.

This treatment may, therefore, be regarded as an alternative to the methods already in use or suggested in the past. Among such approaches to this problem we have: (1) *burning*, a procedure often impracticable and always wasteful; (2) systematic exhaustive *cutting* handicapped by the labour and time factor; (3) *tillage* (disc or plough), frequently obstructed by steep gradient or rocky subsoil of the area; (4) *injection* of sodium chlorate into bracken stumps, a process catalysed by the addition of vanadium pentoxide[4]; and possibly (5) tillage accompanied by *spraying* with calcium thiocyanate, which gave favourable results in the eradication of nut grass[5]; and (6) the introduction of a suitable *fungus* into the bracken stumps.

There is evidence to show that both during its growth and decay bracken exerts an eliminating effect upon other weeds. Should this be substantiated, it could be made to serve as an intermediate stage in the removal of more resistant and pernicious types, such as bindweeds, etc. This may be correlated with the comparative experiments at Wythenshawe Park, Cheshire, and Holcombe Hill, Lancashire, which have established the discriminating action of calcium cyanamide in so far as its efficiency is dependent upon the type of soil, turf and vegetation.

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[1] Copisarow, *Chem. and Ind.*, **61**, 67 (1942).

[2] Recently Henderson (Agr. News letter, Pub. Relations Dept. E.I. du Pont de Nemours and Co., **9**, 72; 1941) obtained satisfactory results with even higher concentration of calcium cyanamide in the case of tobacco plants.

[3] Rotini, *Chim. e l'Ind.*, **22**, 7 (1940); Schmalfuss, *Bodenkunde und Pflanzenernahr.*, **20**, 362 (1940).

[4] Bates, Brit. Rubber Publicity Assoc. Rubber and Agr. Ser. Bull. No. 14 (1940); NATURE, **148**, 753 (1941).

[5] Fromm, *Science*, **96**, 337 (1942).

Water Content of Medusæ; Sexuality in a Planarian

IN recent numbers of NATURE there have appeared two communications which seem to call for comment. In the issue of August 22, Lowndes[1] discusses the question of the water content of medusæ, determining that of *Aurelia aurita* to be 96·56 per cent in sea water of 3·3 per cent salinity. A few years ago I became interested in the same question and also determined the water content of *Aurelia aurita*, finding 96 per cent water in specimens from sea water of 3·2 per cent salinity[2]. Later, I determined the water content of four other species of medusæ, all hydromedusæ, finding 96·5–97 per cent water in specimens taken from sea water of 3·0 per cent salinity[3]. In the first of these papers I reviewed the available data on the subject[4]; these show that in sea water of more than 3 per cent salinity, the water content of medusæ ranges from 94 to 96·5 per cent but that in brackish water of less than 2 per cent salinity, the water content of *Aurelia aurita* may rise to 98 per cent. From these facts it may be inferred that the water content of freshwater medusæ must be very high, and this has recently been found to be the case by Dunham[5], who reports 99–99·3 per cent water in Craspedacusta, thus confirming an old statement by Cremer[6].

IN NATURE of September 19, Goldsmith[7] comments on sexuality in the planarian *Dugesia tigrina* (Girard) 1850 (old name, *Planaria maculata* Leidy). This is the most common freshwater planarian in the United States, occurring throughout the country in ponds, lakes, and streams, and presenting many local and geographic variations. It also occurs, as first noted by Curtis[8], in sexual and asexual strains. In 1937 Kenk attempted to induce sexuality in the sexual forms by various environmental factors, but was unsuccessful[9]. From field data I had noticed that the sexual strain is commonly found in running water or along shores subject to wave action, whereas the asexual strain appears to be confined to ponds and still waters. I therefore suggested[10] that possibly moving water is a factor in the sexual development of this planarian, but shortly after I had published this suggestion I found (unpublished) that this explanation is untenable as regards the sexual strain, and soon Kenk[11] published to the same effect, showing that members of the sexual strain reared throughout life in dishes in the laboratory may become sexual and lay viable capsules. The point raised by Goldsmith had, therefore, already been settled by Kenk. The possibility still remains that there is some relation between permanent asexuality and still water, but this now seems to be unlikely.

The theory of Kenk, which appears to be accepted by Goldsmith, that this planarian has an inherent sexual rhythm is, however, erroneous. In Nature, these worms become sexually mature in early spring and lay cocoons for about three months thereafter. The reproductive system then retrogresses, the copulatory apparatus disappears, and ordinarily there is no further sexual reproduction until the following spring. This cycle is not, however, inherent but is controlled by temperature, as I have shown[12]. The development of the reproductive system, especially of the copulatory apparatus, follows in a few days when the worms are put at room temperature after a sojourn (of two weeks or even less) at a cold temperature (15° C. or below). Stocks brought in from Nature at any time after temperatures have fallen in the autumn and set at room temperature begin to develop sexually in one or two days and start to lay cocoons within a week; although if left outdoors they would not have reached sexual maturity until the following April. Only worms of mature size can be induced to mature sexually by temperature change, and some time must elapse (about three or four months) before sexuality can again be induced in the same individual by manipulation of the temperature.

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[1] Lowndes, A. G., NATURE, **150**, 234 (1942).

[2] Hyman, L. H., *Science*, **87**, 166 (1938).

[3] Hyman, L. H., *Biol. Bull.*, **79**, 282 (1940).

[4] The important paper of Koizumi, T., and Hosai, K., *Science Rep. Tohoku Imper. Univ.*, Ser. 4 (Biol.), **10**, 709 (1936) was unfortunately omitted from this bibliography. They found the water content of Aequorea, Cyanea, and Dactylometra to be 96·4 per cent in water of 3·42 per cent salinity.

[5] Dunham, D. W., *Amer. Midland Natural.*, **28**, 526 (1942).

[6] Cremer, Max, *Sitzungsber. Gesell. Morph. Physiol. München*, **22**, 41 (1906). The statement of Cremer is as follows: "Wenn man bedenkt dass die grösseren Exemplare dieser Tiere kaum einen Durchmesser von 1 cm. besitzen und dass ca. 99 per cent des Körpers dieser Quallen überhaupt aus Wasser bestehen. . ." No grounds for the statement are given.

[7] Goldsmith, E. D., NATURE, **150**, 351 (1942).

[8] Curtis, W. C., *Proc. Boston Soc. Nat. Hist.*, **30**, 515 (1902).

[9] Kenk, R., *Biol. Bull.*, **73**, 280 (1937).

[10] Hyman, L. H., *Trans. Amer. Micro. Soc.*, **58**, 271 (1939).

[11] Kenk, R., *Amer. Natural.*, **74**, 470 (1940).

[12] Hymen, L. H., *Anat. Rec.*, **81** (Suppl.), 108 (1941).

Seed Dispersal by Human Activity

IN a recent paper[1] dealing with weed problems, Prof. E. J. Salisbury has directed attention to accidental carriage and distribution of seeds by human activity, and instances that clothes can be one of a number of means of distribution.

In recent research work on tussock grassland in North Canterbury, New Zealand, with particular reference to the distribution of the nassella tussock (*Nassella trichotoma* (Nees) Hack.), it was demonstrated that clothing can be an important means of seed distribution. The 'cuffs' of a pair of trousers yielded some 17 gm. of seeds and fruits (after five days' field work), the mixture being composed of the seeds and fruits of 33 species of plants, 19 species of grasses, and the remainder of other weeds. Several pairs of socks yielded, among other germinules, more than three hundred 'seeds' of nassella tussock, a troublesome plant rapidly becoming locally dominant in North Canterbury.

The relatively large amount of seeds and fruits present, the number of species and genera represented and the quantity of each, indicated the potentialities of this little-considered means in the distribution of plants, both noxious and beneficial.

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[1] Salisbury, E. J., NATURE, **149**, 594 (1942).

RESEARCH ITEMS

nsects of Norfolk Island

In the December issue of the *Annals and Magazine* *f Natural History* (9, No. 60, 865; 1942) the insect auna of Norfolk Island is discussed by C. N. Hawkins. he account also includes a preliminary report on a ecent collection of insects from that same area. The uthor considers that, generally speaking, the insects f this somewhat remote island would repay much nore intensive collecting and investigation. The ruly endemic species have been extensively supplenented by introductions from other lands through uman agencies. It appears, therefore, necessary to e very careful in drawing inferences from the present auna and to exclude all species which could have een artificially introduced at a time when little ttention was given to such matters. Allowing, herefore, for such immigrants, it does appear that in he main the insect fauna of this island shows more ffinity with that of North-Eastern and Eastern ustralia than with the New Zealand fauna, although here is undoubtedly some connexion with the latter lso. In discussing a recent collection of insects from orfolk Island the author states that it comprises hirty-three species of Lepidoptera, of which only leven are mentioned in earlier lists by various riters. The Coleoptera are distributed among ighteen families and number thirty-eight or more pecies. The Hymenoptera include a number of pecies of ants and parasitic forms. No Apoidea are nentioned and only two species of Vespoidea and ne of Sphecoidea are recorded. Of the Hemiptera, xcluding the Coccidæ, Aphidæ and Aleurodidæ, only hirteen species are listed. The Diptera have not, so ar, been worked out. A special feature of the collection, as a whole, is the considerable number of pecies of wide distribution and general economic mportance that it contains.

nique Freshwater Crustacea

The rivers of temperate South America are inabited by a unique genus and family of fresh-water rustaceans found nowhere else in the world. When atreille in 1818 described a new species as *Galathea evis* he was unaware that it was a freshwater form nd placed it in an exclusively marine genus. Two ears later Leach noticed that it was a representative f a new species but was also worthy of being placed a new genus which he termed Aegla. Since that ime it has been recorded from a number of different calities and is indeed widespread, and several different specific names have been given. The general sage, however, has been to regard all the records as elating to one species, which has been termed *Aeglea evis*, after an incorrect spelling of the generic name troduced by Demarest in 1825. Waldo L. Schmidt *Proc. U.S. Nat. Mus.*, **91**; 1942) has, after the examation of practically all the material available (now uite considerable), provided a detailed and well lustrated review of the genus. He recognizes ighteen distinct species and of two of them a marked ariety. The distribution of the various species is ealt with, and it is noted that a number of them ppear to be confined to the individual watersheds f large tributaries in somewhat the same manner s the limitation of certain molluscan species to ifferent valleys. The Æglidæ appear to be most losely related to the Galatheidæ, and so furnish n example of another crustacean family invading esh water.

Proliferation-promoting Substances from Injured Cells

Observations which suggest that factors, active in promoting proliferation of cells, appear in the intercellular fluids when yeast or animal tissue cells are injured, without rupture of cell membranes, by such agents as ultra-violet rays are: (1) slow injury to cells leads to higher potencies of intercellular fluids than rapid killing; (2) the potency of the fluids increases rapidly before appreciable mortality is noted; (3) the potency is greater when cells are injured in a physiologically favourable suspension medium; (4) active factors appear in suspensions of cells subjected to anærobiosis without killing the cells; and (5) cells killed quickly by grinding and boiling and then subjected to injurious rays yield less potent preparations than cells injured slowly by irradiation prior to quick killing by grinding or boiling. J. R. Loofbourow (*Biochem. J.*, 36, 631; 1942), continuing these studies, suspended *S. cerevisiæ* in distilled water and subjected the cells to injury by ultra-violet irradiation. He found no appreciable change in cell number throughout the irradiation period, which, together with the absence of cytolysis, indicated that the proliferation-promoting factors in the intercellular fluids were released through the membranes of grossly intact cells. Preliminary studies with radioactive phosphorus indicated an increase in membrane permeability during irradiation. Resynthesis of growth-stimulating materials occurred in the living, damaged cells at a rate comparable with the loss of such materials to the intercellular fluids. Of monochromatic wave-bands, that at 2650 A. was the most effective in bringing about the release of proliferation-promoting factors, cell death, loss of cell volume and increase in 2600 A. absorption of the intercellular fluids. There is indicated a correlation between the lethal effectiveness of various wave-bands and their ability to bring about the release of these factors.

Anatomy of Leguminous Root Nodules

Miss Helen L. Frazer's observations upon this subject (*Proc. Roy. Soc., Edin.*, 61, B, Part III (No. 24), 1942) give more precision to our knowledge of the distribution and structure of the endodermal boundaries to be found within these nodular tissues from an early stage in development. They were studied in various common leguminous plants and in all cases (except in some large specimens from lupin) were characterized by the presence of a common endodermis in the outer tissue, in addition to individual endodermal sheaths around each vascular strand. The cells of the common endodermis had a complete suberized lamella from an early stage, and experiments with dyes confirm the natural conclusion that the nodular contents must thus be retained within the nodule even if soluble and free to diffuse from the infected tissues. On the other hand, in the elongate form of the nodules, suberization progressed slowly towards the distal end of the endodermal sheaths around each vascular strand, so that movement of solutes to or from the vascular strand should remain possible in this region and possibly also through the occasional unsuberized (? passage) cells found in the bundle endodermis in the spherical type of nodule. The impermeability of the common endodermis may lead to a reduced air supply in the inner tissues, a condition that has been assumed by some other workers as an inference from the study of nodule respiration.

Eye-Spot of Wheat and Barley

Two recent papers by Miss Mary D. Glynne describe the disease eye-spot, caused by the fungus *Cercosporella herpotrichoides* (*Agriculture*, 49, 2 ; Sept. 1942). It causes a rather destructive type of lodging in wheat crops, and is aggravated by too great a frequency of wheat and barley in the rotation. Oval, brown-bordered spots, shaped rather like an eye, appear on young plants, and black dots later form in the middle of the eye-spots. The disease penetrates successive leaf sheaths, and bad infections weaken the straw. A useful survey of the incidence of the malady (*Ann. Appl. Biol.*, 29, 3, 254 ; Aug. 1942) shows that the disease is more prevalent in eastern England than in North Wales, and reinforces the conclusion that the greater the time after the previous cereal crop, the lower the chance of severe infection.

Californian Sequoias

A STUDY by Looby and Doyle (*Sci. Proc. Roy. Dublin Soc.*, 23, 35–54 ; 1942) of the origin of the gynospore and development of the female gametophyte in *Sequoia gigantea* and *S. sempervirens* shows that marked differences obtain in the number of gynospore mother-cells produced, the form of the spore tetrads, the origin and duration of the tapetum, the growth of the nucellus, the segmentation of the young gametophyte and in alveolar formation. These differences strongly support the recent suggestion of Buchholz, based on post-fertilization and other studies, that the two Californian Redwoods are generically distinct. The name *Sequoia sempervirens* is retained for the redwood while the 'Big Tree' or Sierra redwood reverts to its former title of *Wellingtonia gigantea*.

Recording Plastometer for Organic Plastics

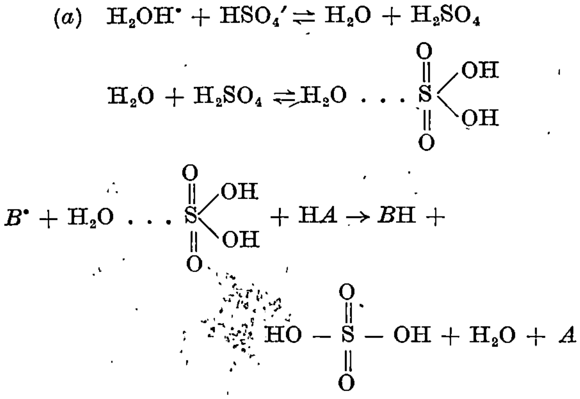
AN article (*Bell Lab. Rec.*, 21, No. 1 ; September 1942) by F. J. Biondi describes an improved parallel-plate plastometer, used to measure the flow properties of plastics, which has recently been developed by the Laboratories to plot automatically the relation between the variables measured. A specimen of the material is deformed by a known force at a specified temperature and the decrease in its height with time is magnified and recorded. The plastometer has two horizontal plates which press between them a small cylindrical pellet of the plastic material. An electrically heated and thermostatically controlled steel block surrounds the specimen, while the frame which supports this block also carries bearings for a shaft connected to the upper plate. A weight, supported by the upper end of the shaft, which is also connected by a universal link to the multiplying and recording apparatus, deforms the specimen. A series of levers and pulleys multiplies the movement between the plates approximately thirty times. This multiplying mechanism and that which drives the paper on which the record is made are housed in a cabinet at the top of the machine. Below the plastometer are the temperature regulating equipment, voltage control and auxiliary switches. An electronic regulator controls the temperature of the steel block within narrow limits from room temperature up to 300° C. Flow curves show that flow occurs more rapidly as the moisture content of the pellets increases, and that in a particular material the average rate of flow can be nearly doubled by changing the moisture content of the pellet two per cent. Moisture is one of the variables which must be measured and controlled if powder of constant flow characteristics is to be supplied to moulding machines. The recording plastometer has also been used by the Laboratories to measure the individual and combined effects of the other variables which affect the flow of plastics.

The System Ethanol-Methanol at 40°

THE system $C_2H_5OH-CH_3OH$ has been studied, from the point of view of vapour pressure, by A. C. Morris, L. T. Munn and G. Anderson (*Canad. J. Res.*, 20, 207 ; 1942). The total-pressure curve plotted against mols per cent is linear, and the partial-pressure curves agree with Raoult's law within the experimental error. This is an interesting result, as both alcohols are generally regarded as 'associated' liquids, and still the system closely approaches an 'ideal' one. Attention is directed to the difficulty of purifying the alcohols, particularly from water, and it is clear that the density is not a 'sufficient criterion' of purity, although in general use for this purpose.

Heavy Oxygen

USING heavy oxygen (^{18}O) water having an excess density of 150–210 γd, E. R. S. Winter and H. V. A. Briscoe (*J. Chem. Soc.*, 631 ; 1942) have studied the exchange of oxygen between water and oxyacid radicals, with special reference to the sulphate and bisulphate ion. Contrary to previous findings, $KHSO_4$ and KH_2PO_4 interchange, though slowly, at 100°. In certain cases the effect of addition of other salts and free acid was examined. The rate of interchange in bisulphate solutions increases with concentration and temperature ; the cation has a marked influence, the interchange being substantially greater with the sodium than with the potassium salt ; and the addition of other (inert) salts or of free acid also increases the rate. The rate is substantially lower for KH_2PO_4 as compared with $KHSO_4$. Although no simple mechanism will satisfactorily explain the experimental figures, it is concluded that the most probable explanation is that interchange occurs through anhydride formation, and this applies to KH_2PO_4 at 100° and K_2CrO_4 at 20°. The mechanism for $KHSO_4$, for example, is either



$$(a)\quad H_2OH^{\cdot} + HSO_4{}' \rightleftharpoons H_2O + H_2SO_4$$

$$H_2O + H_2SO_4 \rightleftharpoons H_2O \;.\;.\;.\; S(=O)_2(OH)_2$$

$$B^{\cdot} + H_2O \;.\;.\;.\; S(=O)_2(OH)_2 + HA \rightarrow BH + HO-S(=O)_2-OH + H_2O + A$$

(where $B^{\cdot}$ and A' are Brönsted base and acid respectively)

$$\text{or } (b)\quad H_2OH^{\cdot} + HSO_4{}' \rightleftharpoons H_2O + H_2SO_4$$
$$H_2SO_4 \rightleftharpoons H_2O + SO_3.$$

Scheme (*b*) is, as stated, preferred.

AGRICULTURAL EDUCATION IN GREAT BRITAIN

AGRICULTURAL education in rural areas of Great Britain was the first subject for discussion at the recent conference of the Agricultural Education Association held at the Midland Agricultural College during January 4–6.

Mr. F. H. Garner prefaced his remarks by saying that the inhabitants of the countryside who are of necessity interested in agriculture are the landowner, the farmer, the farm worker and the parents of children living in the country. Little special effort has been made to educate landowners, but to a very large extent they have received information on all phases of agriculture. The older type of landlord is being replaced by a new type, such as the universities, colleges and insurance companies; the agents who manage such estates have had good training in agriculture and the results are good from the farmer's point of view.

As regards the farmers, the county councils, through the agricultural organizers and their staffs, are in the first instance primarily responsible for their education. A certain amount of work has been done by the National Farmers' Union, agricultural societies and clubs, and so on. A certain percentage of farmers have taken courses in agriculture at the universities, agricultural colleges and institutes. About two years after the outbreak of war, the War Agricultural Executive Committees took over much of the educational work in agriculture through their technical development sub-committees, and in many cases the work was carried out on a much wider scale than had been possible hitherto. These sub-committees could be very active because money was made available for educational work; they were helped by the fact that farmers were getting better prices and consequently could try out recommendations. They have done more to push forward the education of backward farmers than has ever been accomplished before, and it seems most important that such work should be maintained in peace-time. During the last few years, an agricultural bias has been introduced into he teaching at many rural schools, and the Young Farmers' Club movement is extending rapidly; it can be stated that in various ways farmers are eceiving an agricultural education.

On the other hand, there has been very little attempt to provide agricultural education or instruction for farm workers. There have been a few short ourses at agricultural institutes, but generally farm workers have received very little education in rural matters. More recently, but only to a limited extent, ome of the demonstrations run by the War Agricultural Committees have been staged to attract the gricultural worker. Sometimes the workers show no inclination to attend the demonstrations, and there is the added difficulty that these workers, having to arn their livings on the land, are unable to attend if loss of wages results, except perhaps on Saturday fternoons. Demonstrations must be specially lanned for the workers, and farmers must be pproached in order that they may encourage their men to attend. Also, the farm institute courses for he young farm worker must be reintroduced, and his despite the danger that after these young people ave attended their courses they may try to leave he land and obtain more remunerative posts.

With regard to the parents of the country school children: these parents may have various interests, for they may not all be agricultural workers. In the past, this section of the community has received no agricultural education of any kind, and it is quite evident that parents can undo all the good work done by schools, Young Farmers' Clubs, county councils, etc., in maintaining interest in rural activities. Before parents will encourage their children to work on farms they must first be satisfied that housing in rural areas is as good as it is in towns, and that their children can find adequate recreation, both indoors and outdoors, in the villages; that their children will earn as much money on the land as in the town; and that agricultural work is not degrading. Something must also be done to appeal to wives and prospective wives of the farm worker. The courses given in rural schools on domestic science, dressmaking and hygiene are very valuable, but if the girls find that housing conditions in rural areas make it difficult, and sometimes impossible, for them to do as they have been taught, they may be forced, through education, to find houses in the towns.

The ensuing discussion had a very wide range, for several speakers felt that in the matter of agriculture it is not possible to separate rural from urban education. Mr. S. J. Travers, of Kent, believes that urban and rural children should be educated together: they would be on the right lines if they could be made to understand that the land is a national asset and not to be abused as it had been in the past. It was pointed out by Mr. R. H. Smith, Hampshire, that whereas the rural child, through scholarships, etc., has the beginning of a ladder, the urban child has no means at all of obtaining the first steps in agricultural education. Town boys who are eager to take up agriculture may have their enthusiasm killed by being placed in unsuitable work on unsuitable farms. Other speakers also mentioned this question of a 'ladder'. Principal Robinson, Midland Agricultural College, referred to the need for an agricultural education which would give encouragement to the man with ability but lacking the capital to advance up the ladder. He thought a rural bias could well be introduced into education, not so that plenty of skilled labour would be available for the farmer, but to enable even the town boy or girl to appreciate and understand countryside problems. The cry in the past has been cheap food and hang the farmer: unless we educate the rural with the non-rural community, we shall not achieve this appreciation.

The opinion that teachers generally should be educated to the importance of agriculture as an industry was voiced by Mr. W. R. Heaton, Burford Grammar School, who complained that very little financial support is forthcoming for any scheme in agricultural education. He stressed that vocational agriculture should not be taught in schools, but instruction should be given in the underlying fundamentals of biology, chemistry of soils, and some book-keeping and mathematics done from mensuration of farm buildings, etc.

After several members had contributed to the discussion, Mr. John Davies, Glamorgan, remarked that the scope was for ever widening as each speaker seemed anxious to educate yet another class of people. He then asked: Whom do we wish to educate? He believed that the farmer and the farming community are entitled to first consideration, and this opinion was warmly supported by Mr. A. McVicar, Shropshire, and Mr. E. Rea. Mr. McVicar and others said that there is no recognized plan or scheme for a system of agricultural education in Great Britain, and this is urgently needed. It was suggested by Mr. F. R. Horne, of Devon, that not enough attention has been paid to following up the careers of the more promising trainees to see that they become established in agriculture.

The technical development sub-committees referred to in Mr. Garner's paper were both criticized and praised. They were spoken of as an implied criticism of pre-war policy in agricultural education, because if this had not been neglected in pre-war years, there would not now be the necessity for forming these committees. The work of these committees was also stated not to be fundamental education but rather 'tip-giving'. On the other hand, the expansion of agricultural education through the committees *as a national charge* was welcomed, and it was urged that if they are to continue after the War they must be moulded on the right lines now.

A statement by Mr. R. C. Andrew on the Danish system of education for older people caused Mr. R. C. Wood to urge his hearers to familiarize themselves with the writings of Sir Richard Livingstone on the Danish folk high schools. More attention must be paid to adult education and a more cultural atmosphere should be introduced into agricultural institutions in Great Britain.

NORTH SYRIA AS A CULTURAL LINK IN THE ANCIENT WORLD

THE subject chosen by Sir Leonard Woolley for his Huxley Memorial Lecture delivered on November 24 before the Royal Anthropological Institute was the role played by north-west Syria in the first and second millennia B.C. as a connecting link between the civilizations of the Near and Middle East. The region is defined as the area stretching from Lattakia on the present north Syrian coast northwards to the Anti-Taurus Range, and from the Mediterranean Sea to Aleppo. To the south and south-east lay "the commercial kingdoms of Syria and the Phœnician harbours", with Egypt still farther to the south; eastwards lay the homes of the Amorites and the Khurri, leading on to Nineveh. The Euphrates leads direct to Babylon or north-eastwards to the region of Lake Van and the Uratu kingdom; northwards beyond the mountain barriers lay Cappadocia and the Konia plain, leading to the Bosphorus or the Ionian coast; westwards were Crete and Greece, with Cyprus—actually visible from the top of Mount Casius—as a stepping-stone. The nodal position of the region thus chosen is obvious.

Before the War, three main excavations of special interest from Sir Leonard's point of view were in progress: Ras Shamra, just north of Lattakia, the ancient royal city of Ugarit; Al Mina, at the mouth of the Orontes, and the Atchana mound, up the Orontes on the edge of the great Amk plain; and Tal Tayanat, where the Oriental Institute of Chicago has excavated the Syro-Hittite palace. Other recent excavations there have of course been in the Amk plain, and also farther north-westwards as at Mersin on the Cilician coast, but Sir Leonard in the limited time available confined himself principally to the results of his own work at Atchana where, too, the chronological framework devised by Prof. Sidney Smith in his monograph "Alalakh and Chronology" provided him with a gratefully accepted method o correlation with better known cultures in neighbouring lands.

At Alalakh (the Atchana mound) there were unearthed seven archæological levels of buildings pottery, etc., and a trial pit has shown at least three more underneath and as yet unexcavated. Layer 7 has yielded an imposing city gate and a great palace built by Yarim Lim, king of Aleppo and overlord o Alalakh—according to Sidney Smith *c.* 1780–1730 B.C It is contemporary, therefore, with the end of the Egyptian Twelfth Dynasty and the Middle Minoan period of Crete. Near the coast at Ras Shamra Middle Minoan II sherds have been discovered in presumably contemporary levels but, of course, this does not itself prove *direct* contacts. No Cretan ware occurred at Alalakh; all was Asiatic (Khabur ware) and the types persisted down to level 5, *c.* 1483 B.C During 1800–1500 B.C. Alalakh was thus predominantly Amorite. There is evidence (seal-impressions that Egyptian political claims were recognized, bu culturally the town looked eastwards. But while the influence of the West on Alalakh seems at this time to have been slight, Sir Leonard feels that the astonishing resemblance of the palace itself in its plan and construction to that of Knossos, not to mention the style of the frescoes found, suggests, even as Sir Arthur Evans hinted ("Palace of Minos", 2, 269 that migration of Asiatic people to Crete played a part in the rise of the culture there. He adds tha the frescoes at Alalakh are at least a century older than their parallels at Knossos, so that "there can be little doubt as to the originating centre", and argues that North Syria was helping to build up in Crete that remarkable Minoan civilization which wa later to have its repercussions in Asia. In the same way and on the same grounds of architectural resemblances, he suggests that Amorite influenc affected the regions to the north, inspiring not only the late Syro-Hittite buildings of North Syria such as Sakje-Geuzi and Carchemish, but even the mor distant Boghaz Keui in the Halys basin.

In levels 6 and 5 there are fewer remains. It would seem that the influence of Egypt disappeared—thi was the period of the Hyksos domination there—bu the Hittites to the north were becoming an organize power. It was a Hittite invasion of North Syria conducted by Mursil I in 1595, that terminated th local phase represented by level 6. However, culturally Alalakh continued much as before unt Thutmose III conquered the town in 1483. But th weakness of Egypt permitted the folk of the 6t level to be in closer relationship with southern Syri and Palestine, as is reflected in the types of potter found.

Level 4, starting from the Egyptian campaign o 1483, comprises, in so far as its principal building i concerned, three phases, including the enlarge palace of Niqme-Pa, *c.* 1450, which take us down t 1370, when the Hittite king Suppiluliuma invade North Syria and, after destroying the Mitanni kingdom installed his son as king of Aleppo. The main featur of the pottery of level 4 is the prevalence of th Cypriote Bronze Age type. Gone is the old Khabu ware. The better local wares are now either plai burnished red, or have simple bands of colour. All hav a distinctly Cypriote flavour. As the typical Cypriot 'milk bowl' actually occurs at Alalakh so early a level 6 (seventeenth century B.C.) and sherds resembling the Cypriote white slip ware have bee earthed from below level 7, once again Sir Leonard ncludes that, throughout, the main influences wed from the mainland to Cyprus and not vice rsa. To this level, too, must be ascribed certain ulptures of Hittite type which were actually found, -used, in level 1. Sir Leonard sees in these the rect forerunners of the lions of early type at rchemish and of the watergate reliefs of the same ty. His argument is further supported by the nding of a bronze lion dagger, almost an exact rallel to the 'dagger god' represented in the asilikaya rock carvings. Niqme-Pa's palace has pplied one example of Lower Minoan II pottery, d another contemporary one with the familiar topus pattern found in a private house. Ivory rvings, which are clearly copies of Egyptian proto- pes of the time of Thutmose IV, occur, and ntact with Egypt at this time seems to have been ose.

The buildings of level 3 are few and poor. The riod begins with Suppiluliuma's conquest of North yria and lasts until 1285 B.C. Throughout this time lalakh was ruled by the Anatolian Hittites, which ct explains the difference at this period between it d Ugarit (Ras Shamra), which was only fifty miles way, for the latter did not fall under Hittite control. he influx of Ægean settlers and others made of the yrian coast town an outpost of Late Minoan II vilization, but only a very little Ægean influence n be noted at Alalakh.

Level 2 is dated from about 1275 to 1220 B.C. The ain interest here is the occurrence of a local Syrian litanni) ware, the decoration of which is ornate ith bold rosettes in white on a dark ground and imal and bird forms introduced. A development this, apparently peculiar to Alalakh, has all-over signs in which the motifs are running water, aborate stylized lotus plants, and the double axe. he connexion with the Cretan Middle Minoan III indisputable, though no doubt an example of ferred inspiration.

With the fall of the Hittite power in 1220 B.C., lalakh was more open to Ægean influences. Nearly ery grave in Level 1 contains a Mycenæan vase, d doubtless Ugarit was the connecting link. Then me the great movement of the 'Peoples of the Sea' ho swept down, about 1190 B.C., through Anatolia d Syria and were only stopped by Ramses III on e borders of Egypt itself. Ugarit was destroyed, as as Alalakh, and neither site was ever again re- cupied.

To sum up, Sir Leonard Woolley considers that ere is evidence for :

(1) "Direct contact with the Asiatic mainland nfluencing in or before the 18th century the develop- ent of the Cretan civilization."

(2) The existence in the Anatolian Hittite con- deracy of an important element culturally if not cially akin to the Amorite population of northern yria.

(3) A possible Asiatic origin of the Cyprus Bronze ge culture.

(4) Egyptian control of northern Syria in the welfth Dynasty with, later, a relation between the yksos culture and that of the Amk plain.

(5) Direct Late Minoan II and III influences on orthern Syria.

(6) The development of Syro-Hittite art in northern yria long before the beginning of the Syro-Hittite olitical period and of its kinship with the Hittite rt of Anatolia.

ASSOCIATION OF SCIENTIFIC WORKERS

MEDICAL SCIENCES COMMITTEE

AT a conference for workers in the medical sciences arranged by the Association of Scientific Workers, held on January 9 at the London School of Hygiene and Tropical Medicine, Dr. D. McClean (chairman) recalled that the Medical Sciences Committee of the Association was elected in May, 1942, in an attempt to put into operation the policy of the Association in the medical sciences. That policy was the application of science for the benefit of the community and the raising of the status of the scientific worker. The responsibility for the application of medical science to public needs lies with medical scientists (not medical men alone) themselves; means should therefore be provided whereby all medical scientists could consult on methods of improving their work and collaborate in the most effective way in pressing for its application in practice.

Mr. Ben Smith, industrial organizer of the Association of Scientific Workers, emphasized the necessity for organization of workers in the medical sciences if they wish to get their policies implemented. Any activity the object of which is to alter existing conditions is necessarily political in nature, and for political activity organization is essential.

Dr. J. H. Humphrey, speaking for the Industrial Health Sub-committee of the Association, said that owing to the increasing numbers of persons working in factories and the extreme specialization in the work, industrial hazards are becoming more complex and important, while the medical personnel available for their prevention and the treatment of their effects are inadequate. Work on industrial hazards was carried out before the War by the Industrial Health Research Board; during the War, the activities of this body have practically ceased, but partly owing to the efforts of the Association it has recently been resuscitated. The Physiological Society has circularized its members to discover whether physiologists are available for full-time or part-time work on industrial health problems. None were available for full-time work, few for part-time. Liaison with shop stewards has also proved very profitable, as workmen themselves have suggested problems for medical research which might otherwise have passed unnoticed. The main difficulty is less to obtain new knowledge than to get what is already well-known applied.

Dr. Yudkin directed attention to the unorganized nature of nutritional research and gave an account of the efforts of the Nutrition Sub-committee of the Association to obtain co-ordination of nutritional research by pressing for the formation of a Nutrition Council.

Dr. C. L. Oakley spoke on the difficulties experienced by research workers in discovering who are working in their own and closely related fields; ignorance of current and unpublished research leads to much duplication of work and waste of time and energy. The specialization of modern research work frequently requires collaboration between experts in various different techniques. Those who wished to collaborate should be encouraged, and for this purpose he suggested the formation of a central bureau at which research work could be registered in title, and from which information could be sent out to workers in the same or closely related fields. The most natural body to undertake this work might appear to be the Central Register, since it already possesses the names of all active research workers. Nevertheless, it was pointed out that departmental demarcation within the Civil Service might produce obstacles. He emphasized that the Bureau would exist only for collaboration, not for the staking out of claims in special fields of research. Interested bodies are being circularized to obtain support for this scheme.

Mr. Griffin suggested that the present lack of status of laboratory technicians should be remedied by the introduction of a full course of training for them, followed by a qualifying examination; successful candidates to be enrolled in a State register. To effect this it would be essential to have large numbers of technicians in an organization such as the Association of Scientific Workers, which can undertake trade union activity.

Mr. A. L. Bacharach said that for much biological experimental work animals are as essential as pure chemicals are to the chemist. Of the many thousands of animals of many different species so used, a small percentage only are bred for the purpose; the rest are obtained from dealers. Since the suitability of animals for experimental purposes depends almost entirely on their genetic make-up, their freedom from disease and their diet—subjects on which almost all dealers are lamentably deficient—it is not surprising that a large proportion of dealers' animals are unsatisfactory. Besides this, the demand for animals far exceeds the supply. Adequate supplies of pure-bred, healthy, well-fed laboratory animals could be obtained only by tackling the problem on a national scale, by the development of Government-controlled breeding centres. A scheme for the development of such centres circulated to learned societies and users has received sufficient support to justify asking the Medical and Agricultural Research Councils and Ministry of Supply to receive a joint deputation of interested parties.

Two resolutions were adopted by the meeting: the first urged the Ministry of Health to secure the compulsory pasteurization of all milk for human consumption, and to take necessary steps to secure the requisite equipment and to reserve adequate skilled personnel; and the second welcomed the setting up of the Allies' Post-War Requirements Bureau, promised full co-operation of the Association on scientific matters, and expressed the hope that the work of the Bureau includes the preparation of relief immediately following Allied intervention on the European continent.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, January 30—Sunday, January 31

Association of Scientific Workers (at Caxton Hall, Westminster, London, S.W.1). Conference on "Planning of Science in War and in Peace" (to be opened by Sir Robert Watson-Watt, F.R.S.).*

Saturday

At 2.30 p.m.: "The Central Direction of Science".

Sunday

At 10 a.m.: "Local Organisation".

At 2.30 p.m.: "Determining the Future".

Saturday, January 30

Society of Chemical Industry (in the Chemistry Lecture Theat of the University of Sheffield, Western Bank, Sheffield), at 2.30 p.m. Dr. W. H. J. Vernon: "The Corrosion of Metals in Air" (Jubil Memorial Lecture).

Monday, February 1

Royal Society of Arts (at John Adam Street, Adelphi, Londo W.C.2), at 1.45 p.m.—Dr. P. Dunsheath: "Industrial Research Great Britain, a Policy for the Future" (Llewelyn B. Atk'ns Memorial Lecture).

Institution of Electrical Engineers (at Savoy Place, Victor Embankment, London, W.C.2), at 7 p.m.—Prof. C. L. Fortescu "The Relation between Subsequent Career and the Form of Pr liminary Training".

Tuesday, February 2

Institution of Civil Engineers (Structural and Buildin Engineering Division) (at Great George Street, Westminste London, S.W.1), at 2 p.m.—The Rt. Hon. Viscount Falmouth: "Rece Developments in Fire Research and Fire Protection Problems".

Royal Institution (at 21 Albemarle Street, London, W.1), 3 p.m.—Sir Lawrence Bragg, F.R.S.: "The Solid State", (ii) "Plu minus Compounds".*

Wednesday, February 3

Royal Society of Arts (at John Adam Street, Adelphi, Londo W.C.2), at 1.45 p.m.—Mr. G. H. Bates: "Agriculture To-day an To-morrow", 4: "Maintaining the Ploughed-up Area after the War

Institute of Physics (Electronics Group) (in the Lectu Theatre of the Royal Institution, 21 Albemarle Street, London, W. at 5.30 p.m.—Discussion on "Dielectric Breakdown and other Ele tronic Processes in Solids" (to be opened by Dr. H. Fröhlich).

Institution of Electrical Engineers (Wireless Section) (Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. Prof. Willis Jackson: "The University Education and Industri Training of Telecommunication Engineers".

Institute of Welding (at the Institution of Mechanical Engineer Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—A seri of papers on "Developments in Arc Welding Technique".

Thursday, February 4

Institution of Civil Engineers (at Great George Street, Wes minster, London, S.W.1), at 2.30 p.m.—Fifth (final) Discussion Mee ing: "Civil Engineers and the Building Industry—Management an Organization; the Future of the Building Industry" (to be open by Lord Reith).

Friday, February 5

Royal Society of Arts (India and Burma Section) (at Joh Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Colonel S Samuel Christophers, Bart., F.R.S.: "Measures for the Control Malaria in India".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p. —Prof. J. C. Drummond: "History and Knowledge of Scurvy an its Treatment".

Saturday, February 6

Nutrition Society (at the London School of Hygiene and Tropic Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference "Nutrition in Pregnancy".

British Rheologists' Club (at the Royal Society of Arts, Joh Adam Street, Adelphi, London, W.C.2), at 2.15 p.m.—Dr. R. Haward: "The Extension and Impact Resistance of some Plast Materials".

Geologists' Association (at the Geological Society, Burlingto House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. F. A. Banniste "The Determination of Minerals by X-Ray Methods".

APPOINTMENTS VACANT

Applications are invited for the following appointments on before the dates mentioned:

Gas Examiner (part-time) for tests at Uxbridge and Hampto Court Gas Works—Mr. C. W. Radcliffe, "R.2", Clerk of the Count Council, Middlesex Guildhall, Westminster, London, S.W.1 (endors 'Gas Examiner') (February 3).

Lecturer in Mathematics—The Principal, Dudley and Staffor shire Technical College, Dudley (February 4).

Director of the Gas Research Board of the Gas Industry The Secretary, Gas Research Board, Gas Industry House, 1 Grosven Place, London, S.W.1 (February 22).

Master for Engineering—The Headmaster, The Gateway Schoo Leicester.

Lecturer in Engineering (Mechanical)—The Principal, Nort Staffordshire Technical College, Victoria Road, Stoke-on-Trent.

Master or Mistress to teach Physics—The Headmaster, Dove College, Poltimore, Exeter.

Lecturer in Biology, mainly for Botany—The Registra Municipal College, Portsmouth.

Air Ministry, Assistant Mechanical and Electrical En gineers for the Provinces—The Ministry of Labour and Nation Service, Central (Technical and Scientific) Register, Section D.31 Sardinia Street, Kingsway, London, W.C.2.

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UNIVERSITIES AND RECONSTRUCTION

THE address which Mr. Archibald MacLeish, director of the Office of Facts and Figures, delivered before the American Library Association on June 26, 1942, and which has been included in an admirable "America faces the War" pamphlet (No. 16. Total War and the People's Peace. Oxford University Press. 6*d.* net), directs attention to some very important issues. That the whole Nazi regime is an attack on the scholar's world with its freedom of thought, of investigation and of utterance, was realized by many in Great Britain long before the outbreak of armed conflict. Intellectuals generally have now learnt that their world is in real and present danger, but it is not yet appreciated everywhere that it can be saved only by courageous and unrelenting attack.

In the world of science, growing co-operation between British and American workers is encouraging a sense of realism and an understanding of the ultimate issues in the world of the mind, and here we find little hesitation in accepting the necessity of offensive war. Over a wide range of intellectual life, in both Great Britain and the United States, there is still failure, however, to perceive that the defence of the country of the mind involves, as Mr. MacLeish points out, an affirmation, an assertion of a fighting and positive belief in intellectual things, a willingness not only to resist attacks upon their world and on themselves but also to conceive offensives of their own and fight them through and win them. The city of the mind cannot be defended save from its own ramparts, and this conflict cannot be won by arms alone, for it is a conflict fought for men's convictions and ultimate ideals.

Failure to grasp that essential truth is responsible for much of the weakness and ineffectiveness of our political warfare—for the lack of imagination, to take a recent example, which has failed to grasp the opportunity presented by the Beveridge Report. The War might still be lost, Mr. MacLeish reminds us, whatever the victories of arms, if the battles of belief are lost, above all if the battle to maintain the power and authority of truth and free intelligence were lost, the confidence of men in learning and in reason and in truth broken and replaced by trust in force and ignorance and superstition—if the central battle for the preservation of the ultimate authority of mind in human life ended in defeat.

It is idle to deny that that battle can be lost. Harsh necessity has taught the peoples of occupied Europe, no less than those of the United Nations, that the fantastic plans of the Nazis for the conquest of the mind have to be taken seriously. The havoc they have already wrought in Germany is plainly displayed. One by one the lights of learning and freedom of investigation and utterance have been extinguished in the great centres of Western Europe in spite of centuries of proud leadership and tradition. We know now that the task which confronts the United Nations is not alone that of overthrowing the physical power of Nazi Germany, but also of opening again the frontiers of the mind and destroying the dominion which the prostitution of education by this twentieth century barbarism has imposed first on Germany herself and then on the whole of occupied Europe.

That task of liberation might well cause us to pause in spite of the encouragement which we can draw from the Fighting French and the other free peoples who have escaped to continue the struggle while their country and homes lie still under the conqueror's yoke. It is all the greater task on account of the extent to which the confidence of men in learning and in intellectual things has been undermined even among the free peoples. There was never a time, either in Britain or in the United States, when learning was held cheaper than it is to-day, or when men of learning and of letters had less honour.

Mr. MacLeish has well earned the gratitude of scientific workers, along with that of others who are concerned with the preservation of man's real intellectual and cultural heritage, for his courageous summons to the offensive, and his address has been issued at an opportune moment, when the importance of education in post-war plans not only in Great Britain but also in European reconstruction has received renewed attention. The report, "Axis Oppression of Education", issued by the Inter-Allied Information Committee, gives a picture of the German efforts to suppress every kind of knowledge which is likely to conflict with totalitarian theory, and the brutality as well as systematic thoroughness with which they have set about the standardization of thought; it provides ample evidence of the timeliness of Mr. MacLeish's appeal. In the face of the destruction, perversion or appropriation of educational resources thus portrayed, none can doubt the folly of that purely defensive and detached attitude which too many scientific men and other scholars once adopted of watching the steady deterioration of German science and scholarship under the Nazi system, with not only its contempt for learning but also its restrictions on the wellsprings of the creative thought from which all real progress comes.

This record of the closing of universities, the deliberate destruction of all higher intellectual life, the turning of the universities of Czechoslovakia and Poland, of Athens and Salonika, of Brussels and of Leyden into Nazi institutions for the use of the Germans, the destruction elsewhere of all buildings and the plundering of libraries and scientific laboratories, the persecution, torture and murder of professors and students alike, the determined attempt to deprive the occupied peoples of Europe of intellectual leadership, leaves no room for doubt as to the immense problem which will confront the United Nations in this field of education after the War. Even if we leave on one side the question of education in post-war Germany and the measures to be adopted to revive learning and scholarship in ways that will assist the emergence of a new Germany, the building up of education in the ravaged countries is a task that will demand generous help.

That problem was indeed one of those considered by the British Association Committee on Post-war University Education in its interim report (see NATURE, **150**, 716; 1942). Under the third of its terms of reference, the Committee is charged with surveying the position regarding teaching material, apparatus, books and staff in universities which have been damaged, destroyed, disorganized or closed as a result of war, and to make recommendations for their rehabilitation. The report suggests several ways in which such help could be given, including assistance in the provision of equipment and books, the supply of periodicals issued during the War by scientific and other learned societies in Great Britain, apart from the full restoration by the enemy Powers of stolen or destroyed university property.

Possibly even more important than the material restitution or assistance is that of assisting in the provision of teachers and research workers in the universities of the occupied countries after the War. It may be necessary for British and American universities to train teachers and research workers for some of those universities where staff has been killed or dispersed by the Nazis, and to give foreign students special facilities in the Allied universities. The full benefit of research work in progress in Great Britain, in the U.S.S.R. and in the United States during the War must be made freely available in this task of rehabilitation, and those barriers to the frontiers of knowledge which had been steadily growing in the last thirty years must be finally laid low.

To carry out this task, however, makes large intellectual and moral demands on Allied universities and leadership, quite apart from the call to share physical and material resources. The universities have an important, even a decisive, part to play in reconstruction, and they cannot play their part effectively unless we have clear ideas as to exactly what are their functions in time of war and in the society we wish to build after the War. Without clear ideas as to their place and functions in the educational system, we cannot expect to find them endowed with the personnel or the resources which will enable them worthily to play their part in either national or international reconstruction. That conception lies behind both the first and the second terms of reference of the British Association's Committee. The valuable suggestions made in the Committee's interim report with regard to the modification of the policy and methods of university education so as to promote international collaboration and the free interchange of ideas, and to relate university education to the needs and service of the community, have already been discussed in these columns.

The place of the universities in world education is discussed by Miss H. Wodehouse in *Agenda* of October, 1942. In this thoughtful article, in which the dual aspect of the life of the universities, teaching and research, is carefully considered, Miss Wodehouse suggests that the contribution of the university worker to the conduct of affairs will probably be made primarily on the side of the organization of thought. This influence will be exerted through his lucid and impartial sifting out of the fundamental issues, the clarification of problems as well as the unprejudiced investigation of the facts, through sound judgment and resourcefulness rather than through driving power. This involves, however, that no narrow view must be taken of the functions of the university in the dissemination of knowledge. Such functions cannot be discharged solely through teaching; they must embrace the whole field of adult education and whatever new instruments may be placed in the hand of the skilful expositor by scientific advance.

One acute problem must be frankly faced, because it impinges also on the question of the size and organization of universities, as well as their distribution. Miss Wodehouse, it may be noted, would see possibly some limitation on the numbers of universities themselves, if not of the students attending them, but urges a determined effort to improve the standards and conditions of the university colleges. This effort must of course involve the safeguarding of the independence and freedom of utterance and investigation of their teaching as well as of their research staff. This is fundamental, for the universities cannot make their full contribution to the national life unless they are free to handle controversial subjects according to their best judgment without pressure from sectional or prejudiced interests.

That fundamental liberty must include not merely the right of investigation—which in Great Britain has scarcely been denied—but also the equally important right to teach controversial subjects. Unless that right is acknowledged and is used with wisdom and with force, the universities cannot maintain the vital touch with the whole life of the community essential for them to exercise their full power. No task may make more searching demands on the wisdom and judgment of the members of a university, but it cannot be evaded if we are to have an educated people and an electorate competent to meet the demands of democracy. Nor indeed, as Miss Wodehouse shows, is such teaching of controversial subjects either rare or impossible.

In his survey of reconstruction problems in the House of Commons on December 1, Sir William Jowitt devoted his closing remarks to the question of education. There is, as he said, a wide measure of agreement as to the main lines educational advance should follow: the placing of the full-time schooling of the child on a sound basis; the efficient organization of part-time education and of adult education; the establishment of a finer and more intimate relation between industry and education; and the determination of the appropriate units of education administration.

Some of these problems have been reviewed in a pamphlet, "Education: A Plan for the Future", published on behalf of the Association of Directors and Secretaries for Education by the Oxford University Press, and the administrative problems were reviewed in Mr. H. O. Lester Smith's recent book, "To-Whom do the Schools Belong?". The pamphlet just mentioned enumerates for immediate and detailed investigation, first, the recruitment, training and remuneration of teachers; secondly, the re-definition of the areas and functions of local education authorities; and thirdly, the establishment of the Board of Education as the Government Department responsible for the supervision of all educational work. Taken by itself, the third proposition, with its implications in the field of health, might prove incompatible with that overdue overhaul of the machinery and functions of government on the lines of the Haldane Report, while the suggestion that the local education authority is the proper authority to look after both the health and education of children is, to say the least, open to challenge; but there can be no question as to the importance of the administrative problems involved and of bringing to them a new spirit and an open mind in determining the functions of ministries and the relation of research and professional interests to the administrative machine. Clearly it is desirable that each type of authority should be examined to decide on the fact rs which make for strength and efficiency and those leading to weakness or apathy. Such an examination is an essential preliminary to a constructive re-definition of administrative areas which draws on the accumulated experience of the past to provide for the efficient administration of the educational system of the future.

The importance of such questions may none the less be over-emphasized, and in the chapter on university and adult education the Association of Directors and Secretaries of Education does something less than justice to the place and contribution of the universities, both in reconstruction and in the educational system of to-morrow. True, as is pointed out, there should be closer co-operation between the universities and local education authorities in the discharge of their responsibility to the adult population, and the universities may well come to assume much larger responsibilities in adult education by exploring new ways of furthering that object. If education for citizenship and the ideal of public service is, however, to gain its full place in university life, if the emphasis is to be placed on the responsibilities rather than the opportunities of a university career, it will not be sufficient merely to consider questions of access to the universities rather than those of organization and curricula within the university. The British Association Committee and Miss Wodehouse are here on much firmer ground than the Association of Directors and Secretaries of Education.

We shall not secure the most effective contribution of the universities to the reconstruction of Great Britain or of Europe merely by ensuring that all young men and women who have shown their ability to profit by a university education should have the opportunity of proceeding to the university. With that we must at least ensure that there is some acknowledgment of civic responsibility by those admitted, some attempt to fit themselves not merely for a career but also for service to the community. To defer entry to universities until after a year of approved national or international service, whether civil or military, is a wise if not indispensable corollary to the rendering of access to the universities wider and easier for those possessing the ability to profit by such training.

Even if with this goes the institution of entrance tests of the type suggested by the British Association's Committee in its report, the universities may still fail of their full purpose unless they can solve for themselves the ultimate problem of democracy—the reconciliation of freedom and discipline. Their freedom of investigation and inquiry, both in the field of physical science and in the controversial problems on which the social sciences inevitably impinge, must be guarded as jealously as their freedom of utterance, and their right to guide opinion within or without their walls by unbiased and searching inquiry and fearless and frank statement of fact and inference. That freedom and those rights can only be exercised when they are linked to the self-discipline essential in scientific investigation and in the teaching of difficult controversial and living problems. The success or failure of reconstruction may depend on the extent to which the universities succeed in solving this central problem and most searching test of democracy, and in sending out into the world men and women who have not only learned to reconcile for themselves freedom and discipline, but in doing so have also acquired a spirit of service and a zest for life.

The field of reconstruction in Great Britain and in Europe, and supremely the rehabilitation of academic and professional life in the devastated lands of Europe, provide the universities with an unrivalled opportunity to guide and sustain the generous spirit of youth in paths of service to humanity, and will in time repair the havoc which ten years of barbarism have wrought in European culture and learning. The Government's recent decision regarding the calling-up of university entrants taking arts courses should not be considered apart from these wider claims on the universities for the man-power and woman-power to build the peace when the War is won. It would be a disastrous economy to pursue any policy, even in this crisis of man-power, which disturbed unduly the balance of education and deprived us in the post-war years of exactly that type of ardent, trained and intelligent youthful leadership for which Sir Stafford Cripps has so eloquently appealed.

"VIS ET PRAETEREA NIHIL"—THE PSYCHOLOGY OF A DYNAMIST

My Self, My Thinking, My Thoughts

By K. W. Monsarrat. Pp. ix + 140. (Liverpool: University Press of Liverpool, Ltd.; Bickley: Hodder and Stoughton, Ltd., 1942.) 7*s*. 6*d*. net.

THIS book should be read in conjunction with the author's larger work, "Human Understanding and its World", published in 1937. In the present book, Dr. Monsarrat contends that the methods which have been successfully used in elaborating a consistent picture of the physical universe may be equally successful if applied to an evaluation of thought processes and the individuals engaged on such processes.

Dr. Monsarrat points out that when we apply our minds to the study of what used to be called matter, all inquiries as to what it *is* lead to a dead-end because they are unanswerable—the only answerable inquiries are those which ask what it *does*, how it acts. This leads him to deny the existence of any inert or static reality, and to affirm that all items of reality are "power-items". Since the observed properties of an electron are wholly accounted for by its electrical charge, Dr. Monsarrat, as a positivist, feels entitled to regard the electron as an item of energy and nothing more. Inquiries as to the nature and provenance of this energy are improper and unanswerable; they are unanswerable because the first egress of this energy into the realm of the observable is effected through a quantum emission, and the sequence of states and events leading up to a quantum emission is entirely hidden from us. Even apart from this, it is improper to ask what the electron *is in itself*, since our observation only shows what the electron does in a transaction with some other power-item—a power-item 'transacting' in isolation is unthinkable, and the observation of a power-item in action involves a transaction with the observer.

Consequently, since all knowledge is of items in relation to other items, Dr. Monsarrat abandons the search for absolute truth as chimærical and adopts the relative truth of consistency as his critical canon. For him, true and untrue are "synonymous with congruous and incongruous, accordant and discordant". In other words, "truth" is a property of thought transactions enabling them to be carried forward, and without which thought must either cease entirely or blur out into incoherence. The atom, then, is a dynamic assembly of power-items in action, the molecule is a larger assembly of such atomic assemblies, molecules themselves form higher-order "congregates" which by interaction with other congregates acquire stable structure and pattern, giving individuality, form and properties. All individuals are compounded of power-in-action—this view satisfies the consistency canon, and is the only view which satisfies it.

Turning now to a study of thoughts and the thinker, the author at once encounters a difficulty connected with the possibility of observation. He points out that while we most certainly know, since this is an immediate given, yet because psychic processes go inexorably forward in the time-continuum we can never know our own knowing. Introspection is therefore impossible. Dr. Monsarrat obtains access to the character of his own thinking by making the assumption that his own speech-behaviour gives a reliable account of the thoughts which produced it. This assumption is, of course, a very considerable one, and the author appears to furnish no other warrant for it than to point out that it involves no inconsistency—it enables him to prosecute his inquiry in a coherent manner. Analysis of his own speech-forms convinces Dr. Monsarrat that he too is compounded of power-in-action and nothing more, and that so-called material determinations are merely the relationships limiting this power. Matter is thus dispensed with, the body-mind problem ceases to vex, living and lifeless become names connoting no real differences, the metaphysician is finally deflated, and the man of science is left alone in a monistic universe of which he is the sole interpreter. "Influence is fundamentally of one kind—its effects vary only because it is variously organized."

In his earlier book, Dr. Monsarrat had referred to "the essential δύναμις which is, for us, Nature itself".

How do assemblies and organization come about? The author says, "I envisage the atoms as constructed of complementary power-units bound by their need for each other". This archetypal union gives us the clue to the simple formula at the end of the book by which the world may find issue from the ills which beset it. Dr. Monsarrat sees three ways lying open to the world: the predatory way, which is the way of competition, power-politics and grab; the way of fear, which is the way of religion; and the way of grace, which is the way of science and intelligence. His formula for the way of grace lays down that individuals should "seek their own pleasure by discovering what will please their associates, and by giving them these pleasures".

It scarcely needed the writing of a new book to prove that if everyone *were* unselfish the world would be a happier place. What is really needed is a formula for the steady advance of mankind towards the actual practice of such unselfishness, and such a formula science has not yet produced, and indeed shows little prospect of producing. Surely it is foolish to expect such a formula from those who hold that man is merely a complicated molecular aggregate, and that an adequate account of his nature and dealings may be given by reference to the physical observables which he embodies. Man *is* different, and many of his specific differences are touched upon by Dr. Monsarrat in a way which brings home to the reader the fact that the author has not met with a full measure of success in complying with his own self-imposed critical canon of consistency. He admits that certain individuals (metaphysicians, ore gathers) indulge in processes of abstraction the product of which is "fantastic"; he maintains that common-sense opinions issue from a haphazard survey guided only by desire; he points out that the predatory way and the way of fear have been the ways of choice for the greater part of the individuals in human history so far. There are then, and history shows that there always have been, trends of the whole individual which run counter to other trends of the same whole individual, and a monistic science cannot integrate these two sets of tendencies into a unitary framework, still less can it heal the conflict between them.

It is not clear what exactly the author conceives power-in-action to be, nor whether he understands power-not-in-action to be a possibility. In his earlier work he stated that the properties of an electron are wholly accounted for by its electrical charge, "electrical charge being a term we use to describe a particular sort of behaviour". There are still minds which reel at the thought of behaviour with nothing behaving, of action without an agent, or of patterning without something patterned, and it may be doubted whether this book will dispel their last doubts. The author makes great use of the idea that the concept of power is derived from the fact that the individual's first, primitive and irreducible affirmation is an affirmation of himself as *able and acting*, but he neglects the fact that this is an affirmation, not of unsubjectivated acting, but of the *self's* own action—*I* am acting; *I* am knowing.

With the best will in the world, I was unable to find that the numerous diagrams threw any light on the matter under discussion in the book.

J. Leycester King.

First Steps in Astronomy without a Telescope

By P. F. Burns. Pp. x+214. (London: Ginn and Co., Ltd., n.d.) 5*s*.

THE late Sir Frank Dyson, when speaking on an educational platform, used to express his disapproval of the omission of so fascinating a subject as astronomy from schemes of science instruction in schools. Nor was he satisfied with the reply that the skies are most attractive when children ought to be in their beds asleep, and that anyhow telescopes are not so easily come by as test-tubes. So much is experimental work preferred to observation and calculation that, as the author of this book says, very few children leave our schools with even a fragmentary knowledge of the starry heavens and of the place of the earth in the universe. To those teachers who would like to remedy this defect, Mr. Burns's book will at once appeal. In writing it he has had also in mind young people who are members of the A.T.C. or J.T.C., or who as guides and scouts study for the astronomer's or star-man's badge. The needs of adults also, who wish for guidance in the study of the heavens, have definitely determined both the approach to, and much of the subject-matter of, this introduction to outdoor astronomy. The book is clearly written, carefully graduated, abundantly illustrated, and beautifully produced. It should take its place not only as a text-book, but also as a gift-book.

Control of the Common Fevers

By Twenty-one Contributors, arranged with the help of Dr. Robert Cruickshank by the Editor of *The Lancet*. Pp. vi+361. (London: *The Lancet*, Ltd., 1942.) 12*s*. 6*d*. net.

THIS is a book which will appeal to a large circle of readers, especially health officers and laboratory workers. The subjects discussed are diphtheria, streptococcal infections, scarlet fever, erysipelas, puerperal sepsis, rheumatic fever, pertussis, measles, the common cold, epidemic influenza, the pneumonias, enteric fevers, bacterial food poisoning, bacillary dysentery, gastro-enteritis, undulant fever, cerebrospinal fever, poliomyelitis, catarrhal jaundice, Weil's disease, small-pox and the Rickettsiases. The text is liberally interspersed with charts and diagrams, and a short bibliography of mainly British and American works is appended to all but one (puerperal sepsis) of the chapters, while suggestions for further reading are made at the end of the book.

A Handlist of the Birds of the Sevenoaks or Western District of Kent

By James M. Harrison. Pp. xviii+165+68 plates. (London: H. F. and G. Witherby, Ltd., 1942.) 30*s*. net.

MR. HARRISON'S book is a large and detailed work. The forty-one coloured plates are from good original water-colours by the author, and there are several half-tone and line illustrations.

The observations recorded are those of the author gleaned over a period of twenty years, correlated with those of as many other ornithologists as the author himself could discover. A bibliography, glossary of scientific terms and an index are appended. The work is necessarily specialized and will appeal mainly to those living in the west of Kent and to other British ornithologists.

GOVERNMENT AND SCIENCE IN GREAT BRITAIN*

By The Right Hon. SIR STAFFORD CRIPPS, P.C.

THE problem of the utilization of the scientist in the war effort is one that has been much discussed, though there is in reality no difference in the principles that should be applied in time of war and in time of peace. Whether it is for the purpose of winning victory in war, or of winning decent standards of living in peace, we should equally desire to utilize the highest degree of scientific knowledge in our industries.

There are two main factors in this problem: the provision of an adequate supply of skilled scientific staff, and the proper utilization of the scientific staff available. The neglect of scientific organization, and the failure to appreciate to the full the great part that science was bound to play in a modern war, led us, in the pre-war years, to neglect the organization of the scientific side of war. This we have attempted to remedy in the typical British way by improvising an *ad hoc* organization to deal with the various problems as they arose. We have not created a tidy, blue-print plan of scientific organization of the war effort, but have rather attempted to make the best use of our resources at those points where the resources seemed likely to produce the most valuable results in the quickest time. Hence our structure is one which it is easy to criticize as lacking method and orderliness, but, on the whole, it has, I believe, done as much for us as would any more tidy plan have accomplished, unless such a plan had been laid down and worked out well in advance. In sketching that organization it is perhaps easiest to start at the top.

There are five members of the War Cabinet who are, more or less, directly concerned with scientific matters and who thus represent in the War Cabinet some portion of our scientific effort. In addition to them, the Paymaster-General is a pure scientist and, in a very direct way, is able to assist and advise the Prime Minister who is, of course, Minister of Defence also, upon scientific matters.

In the War Cabinet, the Lord President of the Council is responsible for the Scientific Advisory Committee, which has wide terms of reference upon all scientific matters; and through that Committee the Cabinet is in touch with the Royal Society and with all the principal learned societies of Great Britain. The pooling of scientific knowledge throughout the Commonwealth is assisted by the Committee's association with the scientific liaison offices of the Dominions, and valuable contacts for the exchange of information have also been established with the appropriate bodies in the United States. The Lord President is also responsible for the Engineering Advisory Committee, which carries out similar functions in the field of engineering.

The Council referred to in the Lord President's title is, of course, the Privy Council, and this has long been associated with scientific research. It is the parent body to the Agricultural Research Council and the Medical Research Council, and to the Department of Scientific and Industrial Research, which originated in the War of 1914–18. This latter body is, in its turn, responsible for the National Physical Laboratory and many other research bodies and organizations; and is in intimate association with other research associations both Governmental and industrial. All these are, as it were, centralized research and advisory bodies serving equally any Department.

Next we come to the Minister of Production. Last September three distinguished scientists were attached to the Minister of Production in an advisory capacity as full-time employees of the Government. These advisers are available to assist in all the Departments and can recommend measures for more effective co-ordination. They also act as a link with the British Central Scientific Office in Washington, which co-operates with the members of the supply missions in their joint working with American science. In addition, the Minister of Production is responsible for the Radio Board, which was set up recently to co-ordinate the whole of the work on radio in all the Services, including the Post Office. I preside, in my personal capacity, over this Radio Board on behalf of the Minister of Production.

The Minister of Labour and National Service is responsible for the Central Scientific Register and, in collaboration with the universities, the professional institutions, and the other Government departments concerned, as well as with organizations in Canada and the United States, he has seen to the training and mobilization of our scientific man-power. This has been a most difficult task, especially having in view the enormous growth of scientific personnel required in the Services for operating some of the newest devices.

The Minister of Home Security deals with the specialized scientific needs arising out of the problems of security against air attack, and is responsible for a research and experimental department concerned primarily with protection against the effects of bombing.

The fifth member of the War Cabinet is, of course, the Minister of Defence, and he is connected with the scientific side of the defence services for which the two Secretaries of State and the First Lord of the Admiralty are responsible. He also acts as chairman of the Anti-U-Boat Committee, which deals, among other things, with the scientific side of the anti-U-boat warfare.

So much for the highest level. Next we come to the various supply ministries and the fighting Services. There is a host of liaison committees at different levels between these different Ministries for the exchange of scientific information and experience, but each has its own scientific organization under a director of scientific research. The Ministry of Aircraft Production also has an important organization devoted to radio development, under the controller of communications equipment; though there are, in addition, many scientists operating outside the research sphere, both in development and production, and on operational planning.

One of the most marked developments during the War has been the growth of the application of purely scientific methods to operations, and there are now large scientific staffs in all three Services devoting their skill and energy to operational research.

Co-ordination of Planning and Development

The need for close linkage between the experience in the field and the planning and development of new weapons has been fully realized and methods for obtaining this have been gradually improved as the War has proceeded. Recently a new deputy chief of the Imperial General Staff has been appointed with the responsibility for ensuring that the Army requirements—and the means of fulfilling them—are projected against the background of modern science and research. In addition to being a member of the Army Council, he is a member of the Ministry of Supply Council and of a number of technical committees of that Ministry. He has under him a scientific adviser to the Army Council, who is also a member of the Scientific Advisory Council of the Ministry of Supply.

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* Address before a conference of the Association of Scientific Workers on "Planning of Science: in War and in Peace", held during January 30–31.

In the same way the chairman of the Aeronautical Research Committee is also a member of the Air Council and of the Ministry of Aircraft Production Supply Council, thereby giving a scientific link between the Air Ministry and the Ministry of Aircraft Production.

On the whole range of specialist committees, dealing with every aspect of the air programme, the Air Ministry, the Admiralty, and the Ministry of Aircraft Production are represented.

In the main testing establishments there is complete co-ordination between Service and civilian staff, who together carry the responsibility for testing. In a similar way the controller of communications in the Air Ministry is also controller of communications equipment in the Ministry of Aircraft Production and sits as a member of the Radio Board; as also does his vice-controller in my Ministry, who is also scientific adviser on telecommunications to the Secretary of State for Air. In this way we have been able to co-ordinate closely the work between the scientist and the Service user.

I have given these indications of the method of organizing scientific work and co-ordination in order to show that at many levels there is a close integration of the work.

This is not to say that, with ample staff and plenty of time, some better organization might not have been elaborated; but it is sufficient, perhaps, to indicate that the Government attaches the very highest importance to the proper utilization of our scientific effort and has gradually built up during the course of the War a machinery which, from the practical utility point of view, has enabled us in many branches of science to keep well ahead of our enemies.

Government and Industry

A great deal of our scientific strength in Great Britain is of course not in the employment of the Government at all but in the employ of private companies. Many of the great pre-War industrial organizations already had highly skilled research laboratories, which they have extended and which are now working whole-time on Government work.

It is not an easy matter to co-ordinate these organizations, as there has been, in some cases, a not unnatural reluctance for industrial research departments to pool the results of their research, though in other cases this pooling has been done most willingly and to the fullest extent. All these research organizations are, in one way or another, linked up with the various Supply Ministries, though we have not yet reached a perfect method of co-ordination and there is still, I believe, room for a better integration of this section of research and development.

There is one additional feature which I should mention, and perhaps I may do this especially in association with my own Ministry. We have an Aeronautical Research Committee with a number of sub-committees, the members of which are drawn from technical Government staffs and independent scientists with the necessary qualifications. From time to time the membership of these bodies is changed with the view of giving a freshness of outlook; but the difficulty is, of course, now being felt that so many scientists are either in Government or industrial employment that it is not easy to find independent scientists to serve.

In addition to this, there are advisory committees from the industries themselves consisting of engineers or scientists to whom specific problems may be referred or from whom advice may be sought upon the way to tackle definite questions.

I think that our main difficulty with regard to the proper utilization of the scientists in this war has been our failure to realize, at a sufficiently early stage, that this was going to be a truly scientific war, and that the battle would not be won merely by the physical ascendancy of our race but rather by the ingenuity of those who have been trained in our secondary schools, technical colleges, and universities. This realization has gradually grown upon the country and we are now fully alive to the fact that our survival and our victory depend to a great extent upon the output of our scientists and our research institutions, and that everything must be done to utilize to the full that very high degree of scientific intelligence which Great Britain undoubtedly possesses.

We need not be too critical of the exact manner in which that scientific knowledge is made available, provided only that it is made available and that there are no difficulties from those who still, perhaps, fail to realize fully how great a part science must play.

The scientists of Great Britain have undoubtedly achieved the most remarkable progress during the years of the War, but we must do everything in our power to maintain the lead that we have gained; I know that, as in the past our scientists have without stint given their services and their devotion to the country so, too, in the future we can look to them for new implements and new devices which will make our salvation certain and will hasten our victory.

THE PLANNING OF SCIENCE

AN open conference on the "Planning of Science" was held in the Caxton Hall, London, on January 30 and 31, under the auspices of the Association of Scientific Workers. Perhaps the most significant comment on the subject was unspoken. For the first time those wishing to confer on the planning of science presented a substantial problem in London traffic control; 30 per cent of those wishing to attend the first session were—despite resort to a remarkably uncomfortable scale of overcrowding—unable to hear the discussion even from the lobbies; overflow accommodation, regrettably unavailable for the first session, had to be made available for the third; the least well-attended session was still a large gathering. No better index of the radical change in public interest need be sought.

Sir Robert Watson Watt, president of the Association of Scientific Workers, at the conclusion of his opening remarks, read a message of greeting dated from Moscow, January 29, 1943, from Vladimir Komarov, president of the Academy of Sciences of the U.S.S.R., and Nikolai Derzhavin, chairman of the Soviet Scientists' Anti-Fascist Committee and member of the Academy of Sciences of the U.S.S.R., in the following terms :

"The role of science is a particularly big one in this War. It was with great satisfaction that we learned that British scientists are devoting their Conference to questions leading to the solution of problems connected with the rapid rout of Hitlerism.

"Since the War broke out Soviet scientists have devoted all their energy to the war effort. Under war conditions, all Soviet scientists have turned their efforts in one direction—to help the Red Army and the industry of the U.S.S.R. This has meant the complete reorganization of all scientific research work. It was necessary to select a few of the many problems on which the Academy of Sciences of the U.S.S.R. was working, those few which gave an answer to war-time problems.

"The Institutes of the Academy of Sciences selected, from among the subjects being worked on, those which are of importance to the War. The programme which was drawn up in this way was communicated to military organizations, who confirmed the importance of the subjects mentioned, and added new problems interesting the Army and Navy. After this, we held a number of conferences with leading commanders of the various arms of the Fighting Services and with leaders of the defence industries. The result was that we were able to concentrate the efforts of our scientists on the most important tasks and also to make full use of our numerous institutes and laboratories.

"The results of 1942 show that we have given great help to the Red Army and have been able to provide the front with many new weapons.

"The reorganization of the work of the Academy of Sciences of the U.S.S.R. in order to satisfy the needs of the Army, made a number of organizational measures necessary. In the early days of the War, the Academy of Sciences organized a Commission for the Mobilization of the Resources of the Urals, Western Siberia and Kazakhstan for Defence Needs. This Commission is working under the guidance of the president of the Academy of Sciences of the U.S.S.R., Vladimir Komarov. The significance of the work done by the Commission may be judged by the fact that the workers of the Commission received Stalin Prizes in 1942.

"Three other Commissions are working for the purpose of mobilizing scientists for defence : first, the Naval Technical Commission, consisting of representatives of the Academy of Sciences, naval establishments and scientific research institutes outside the system of the Academy ; second, a War Medicine Commission ; third, the Commission for the Mobilization of the Resources of the Volga and Kama Districts for Defence Needs. In addition to the work of strengthening the might of the Red Army, scientists of the Soviet Union are continuing their theoretical investigations.

"Without analysing the measures proposed by you for organization of the work of scientists in your country, measures which are dictated by the specific features of the country concerned, we express our confidence that our colleagues in science will take all necessary measures to hasten the rout of the Hitlerite gangs and bring nearer the complete victory of the United Nations."

The Conference then listened (by the courtesy of the B.B.C.) to a recorded exchange of greetings by trans-Atlantic telephone, between Dr. Harry Grundfest, of the Rockefeller Institute for Medical Research and national secretary of the American Association of Scientific Workers, and Sir Robert Watson Watt.

The Central Direction

Sir Stafford Cripps (whose address on "Government and Science" is reproduced in full on p. 152 of this issue) outlined the somewhat complex structure of ministerial, departmental and extra-departmental groups concerned with governmental control of science in application to the war effort in Britain. A schematic diagram was included in the exhibition of photographs, diagrams and printed matter which formed part of the Conference. While the diagram is known to contain errors of balance and detail, it is a useful preliminary attempt to bring the present British arrangements into a single picture.

Sir Alfred Egerton presented a corresponding outline of the arrangements in the United States of America.

Dr. David Shoenberg, who has worked under Kapitza in the Institute for Physical Problems of the Academy of Sciences of the U.S.S.R., Moscow, spoke on "Wartime Science in the U.S.S.R.". He supplemented his account of the structure for central direction of the scientific effort in U.S.S.R. by reading the organizational portions of the greetings from Moscow reproduced above. The general organization outlined by Dr. Shoenberg was also represented diagrammatically.

Existing Systems

It was not unnatural that the detail of the pictures seen across an ocean or half a continent should appear simpler than that of the close-up. But over-simplification in presentation of the less familiar systems of the United States and the U.S.S.R. could not wholly account for the criticisms of that of Great Britain. The Conference may not have judged the organizations catalogued by Sir Stafford Cripps as harshly as did the speaker who quoted Lord Chesterfield's opinion, according to the Duke of Wellington, of the generals of his day : "I only hope that when the enemy reads the list of their names he trembles as I do". There was, however, found no one to go beyond Sir Stafford's qualified enthusiasm : "on the whole . . . done as much for us as would any more tidy plan . . . unless . . . worked out well in advance".

Speakers who had first-hand knowledge of conditions in the United States and the U.S.S.R. emphasized the large scale of provision for research, for scientific and technical education, and for the application of science by both these allied nations. The general lavishness of their support for science, the magnificent facilities, the numerical adequacy of the research teams and the scale of technical help and workshop services were all contrasted with the limited provision at home. "Boston Tech." and "Cal. Tech." are the giants of their class, but the somewhat smaller institutes in the U.S.S.R. are no less generously appointed.

Dr. Shoenberg gave an impressive account of the way in which scientific work was from the beginning linked to purpose, and of the "conscious planning" which distributed inter-related problems over a number of institutes, with consequent avoidance of overlapping, and facilitation of collaboration. He emphasized the scale on which long-term biological research is being maintained in the U.S.S.R. and contrasted this policy with the British policy of diverting biologists towards filling gaps left by our inadequate supply of physicists.

The speed with which the gap between research and production could be bridged in the United States was illustrated by the case of a pilot plant for a new explosive-manufacturing process. This plant was in production within thirty days of the conference between the university chemist and the chemical engineers. Sir Alfred Egerton, who gave this example, selected "the high scientific importance of the Industrial Research laboratories" as the greatest difference between the United States and Great Britain.

The Ages of Wisdom

The most insistent criticism of the existing arrangements in Great Britain was directed against the general failure to bring the young scientific and technical workers in the laboratory or the plant into the formation of policy, the implicit assumption that the most distinguished men are the oldest men, the septuagenarian, octogenarian and (in one case) nonagenarian chairmen, the obstacles preventing the minor member of the scientific democracy bringing his views to the governing body.

It was recognized that the young worker should not be snatched from his productive work to full-time service in governing or co-ordinating bodies, but it was regarded as impossible for the most modern scientific technique to be represented by the once brilliant laboratory or plant worker who has been so long in 'management' that he is no longer in touch with the thoughts and ways of his immediate successors.

The Conference was reminded of C. K. Mees's dictum that "the man on the job knows most, the Director of Research very little, the committee of Vice-Presidents nothing at all".

There was constant emphasis on the need for planning and co-ordination from below, to complement and consolidate with planning and co-ordination from above.

Closely related to this group of comments was that which called for direct contacts between the relatively junior executive officers in the Fighting Services and the junior scientific workers who could solve the problems posed by their serving contemporaries.

A Central Scientific and Technical Board

Mr. E. D. Swann, speaking for the executive of the Association of Scientific Workers, reviewed the deficiency in the applications of science to the war effort which the Association discussed in its earlier Conference, and the partial rectification which has been achieved in the intervening year. These deficiencies include failure to pool information and facilities, to concentrate effort on vital war needs only, to ensure full co-ordination between Government departments and between these departments and industry, to utilize fully the initiative of the individual worker.

Towards the fuller rectification of these defects the Association proposes the setting up of a Central Scientific and Technical Board, composed of scientifically and technically qualified persons. This Board would be in direct contact with the War Cabinet and able to raise items on its agenda. In this important respect the proposed Board would differ from the existing advisory bodies. Its functions would be to advise the War Cabinet on scientific matters and to relate the country's scientific effort to the strategy determined by the War Cabinet. In relation to science the Board would possess executive powers enabling it to survey scientific problems, to allocate priorities to the various problems and the necessary resources to deal with them. It would establish the date by which scientific projects should reach completion and review their progress and the resources allocated to them from time to time. The Board would need the authority to initiate or stop programmes of work and to transfer personnel where necessary. It would also need powers to demand any scientific or technical data from any firm or industrial department.

It was clearly recognized that over-planning of science may produce a greater measure of frustration than does our present scale of under-planning. What is sought is a system which will make it easy for the individual scientific and technical worker to give his full effort, with adequate facilities, in that grouping which is best adjusted to the need of the moment, and with an understanding of the broad reasons for its programme in relation to that need.

"We do not want the individual worker to spend a large part of his time explaining to central planning boards what he would have been doing if he had not been explaining to them. We do want the central boards to help the workers to do their work better, by explaining to them why they are asked to do certain things in a certain grouping at a certain time. But mainly we want to ensure that the things and the grouping and the timing are part of one integrated plan of utilization."

Science and the Soldier

Air Chief Marshal Sir Philip Joubert said "the association of science and the fighting man is no new thing. But perhaps it has reached its highest development during the adolescence of the Royal Air Force". He described the "harmonious co-operation of science and the military art which achieved outstanding success in the Battle of Britain".

Sir Philip's main theme was the growth, the essential nature, and the necessary limits of operational research.

"The desirable situation is when the Service side realizes a series of needs and passes straightforward questions to the scientist. Such questions must, of course, be capable of consideration by scientific methods. By this I mean they must be questions of fact, not of theory. The facts of the war in the air can be clearly stated. For example, it may be necessary to decide how many flying hours with so many aircraft are required to achieve a certain result. Given past experience, scientific analysis will quickly provide the answer to this question. Naturally, all the questions are not so simple in form.

"The position becomes more complicated when the military staff are not quite certain what they want and are unable to state their case clearly. The scientist then must grope for his solution and it is here that a very serious difficulty may arise.

"The prosecution of war is, in principle, an art. The methods to be employed are based on past experience and study, but their application to a particular problem must be a matter of judgment. The military man, by education and experience, if he is to succeed, must have this judgment. The scientist is not fitted, either by his training or his experience, to exercise that judgment. But if he is insufficiently guided by the military staff, in the course of his researches he is almost certain to trespass into the realm of military art. It is therefore of the utmost importance that the military staff should give the scientist the clearest guidance on his duties.

"If, however, the scientist never initiates any action and always waits to be asked a question by the military staff, he will lose half his value. It is a truism to say that the solution to a problem which puzzles those who are constantly working on it is often grasped very quickly by a new-comer, and it is certain that the advent of the Operational Research Sections has resulted in many difficulties being cleared away by the sound advice they have given. I must, however, insist upon the point that this advice should be confined to the purely factual aspect of any problem. To my mind it is not the business of Operational Research Sections to advise on future operations. They can examine past operations and draw conclusions from them, but it is for the military staffs to apply these conclusions as modified by their military judgment."

The natural extension of the methods of operational research into post-war life generally was treated by a member of an operational research staff in a thoughtful and stimulating contribution, one of several from which the importance of operational research methods emerged very clearly.

Science and the Educational System

It was noteworthy that the first and the last addresses to the Conference, as well as many between, ascribed the major obstacles to full utilization of science in the service of humanity to the unbalance in education between science and the 'humanities'. This diminishing but persisting unbalance, it was stated, accounts for the famine of scientific and technical workers which now faces us. It accounts, too, for the disproportionate effort required to convey to the administrators, the politicians and the industrialists the true nature of science in the service of civilization, its method and its possibilities.

It is, however, impossible to await the radical cure, which requires first the re-education of our educators. The process must be undertaken, but we must simultaneously take measures which will have earlier effect.

Science and Parliament

The Parliamentary and Scientific Committee owes to the Association of Scientific Workers alike its foundation and its resuscitation from the remarkable suspension of its activities which was decided on at the beginning of the War. The Committee goes far towards solution of the problem of acquainting Parliament with scientific opinion on all matters of current importance. It aids the presentation of questions and resolutions in Parliament, and approach to Ministers by deputation and interview.

Lord Hinchingbrooke offered advice to the Conference on the technique of bringing scientific ideas into the forum of Parliament. He said that politicians are people who know a little about a very great deal, and urged the need for showing clearly the application of any idea presented, and for avoiding dilution of important information by its inclusion in bulky and frequent collections of miscellaneous matter.

Prof. S. Chapman, while refusing to accept politics as anything higher than a regrettable necessity in the relations of science and the community, is convinced that scientific workers should be of and among the legislators, should be in the Mother of Parliaments as of right and of duty. Science should be recognized as one of the Estates of the Realm, and should have its life representatives in the Upper House. These "bishops of science", men and women, should be chosen by the scientific workers themselves, and should come from the age groups of the thirties and forties as well as from the fifties and sixties. They should number twenty rather than two, they would not necessarily be the very best scientists, but should have knowledge of politics and affairs in addition to their scientific knowledge.

Science and Industrial Managements

Colonel W. C. Devereux, managing director of High Duty Alloys, Ltd., spoke as a "professional manager", from that inarticulate class called "management".

"I hope I am right in believing that the day is past for ever when the scientific worker in industry—the works chemist or metallurgist—was regarded by the management as a necessary evil; as someone who should be put away quietly in a dirty little shack miscalled a laboratory, and brought out only to put on the carpet and abused for anything that had gone wrong, or to produce an immediate solution to any troubles which would not yield to more direct methods of attack. To-day, the value of scientific research and control is appreciated by progressive management as an essential part of a manufacturing organization. I do not believe that good management, and by this I mean competent men who understand the technical processes they control, finds any great difficulty in interpreting and applying the recommendations of the scientific workers. The greater difficulty is to convey to the scientist the problems requiring solution and to direct him along the right lines of investigation."

Kettering, of General Motors, sums up the position very wisely when he says: "It may not always be the best policy to adopt a course that is best technically, but those responsible for policy can never form a right judgment without knowledge of what is right technically".

After outlining the organization of the scientific and technical staff in his own companies—on a scale exceptional in industry—Col. Devereux quoted the results of two investigations initiated by his economy committee, one for fuel economy in which the £35,000 capital expenditure incurred in providing re-designed combustion chambers and the like was saved within the first year of use, and one for modifications in a bought-out material, the cost of the investigation being repaid by the savings on a single day's purchases.

Col. Devereux was critical alike of the research associations and of the existing national laboratories. The former "have not so far been a really important factor in industrial development. This is readily understandable when one considers the . . . lack of backing which these organizations receive from industry and the Government." "Our existing national laboratories . . . sometimes become a sort of blissful oasis where certain scientific gentlemen can browse in quiet seclusion to their hearts' content." His constructive prescriptions for a better state of things deserves more space than can be given in this summary of nine hours of wide-ranging discussion; he proved himself a powerful and stimulating friend of the scientific worker.

Joint Production Committees

A substantial proportion of the detailed discussion on the immediate fuller application of scientific and technical knowledge to war production was devoted to the problem of Joint Production and Advisory Committees in industry. The Association noted with special satisfaction the acceptance by the Minister of

Aircraft Production of its contention that scientific and technical staffs should have their own representation alongside 'management' and 'labour' in these committees. The strength of the resentment felt by the Conference in relation to "the deliberate policy of the Employers' National Federation to exclude from the Joint Production and Advisory Committees any representatives of the staff" was unmistakable.

A representative from Hayes made a valuable contribution describing the success of local co-operation between scientific and technical staff and other organized groups of the labour force towards mitigating the evils resulting from this exclusion from Joint Production Committees. Only one speaker was able to present himself as an actual member of such a Committee, although another was able to underline the absurdity of a situation in which one technical worker, excluded from membership of a Joint Production Committee, has already been co-opted to the Committee on four separate occasions to help in the consideration of special problems.

International Co-operation

Throughout the discussion there was constant reference to the need for closer inter-Allied co-operation, and in particular to the need for wide extension of the existing arrangements by which young workers from the war laboratories visit their colleagues in other countries, not merely for discussion but also for work side by side in Allied teams. It was emphasized by Sir Robert Watson Watt that only the indispensables should be spared from this vital work.

The inadequacy of the initial response by the United States and Great Britain alike to the U.S.S.R. offer of help on the synthetic rubber problem was cited as an example of grievous failure in inter-Allied co-operation, not yet incapable of rectification. Immediate action, again by way of a personal mission of young and active workers, was called for.

Determining the Future

The contributions by Sir Lawrence Bragg, "The Position of Scientists after the War", by Prof. P. M. S. Blackett on "The Rehabilitation of Fundamental Research", and by Prof. H. Levy on "The Basis of Scientific Planning", introduced the discussion, in the third and final session of the Conference, on "Determining the Future". The proceedings at this long and crowded session were of such importance that they merit separate treatment. No attempt is, therefore, made to summarize them in the present review.

Summary

The points on which the most vigorous criticism, and pressure for reform, were expressed in the Conference were:

(1) The need for a stronger, simpler and more closely knit fabric of central direction of scientific effort in the War, controlled by active scientific workers with full knowledge of War Cabinet policy and current strategy.

(2) The need for constant participation by the young scientific worker in the shaping and direction of policy and in its execution.

(3) The need for direct interchange of view between the junior user and the junior scientific worker. (This was admirably summed up by Mr. Hilton Brown in a broadcast to schools on February 2, in which he showed the junior military officer and the junior scientific officer at the foot of the two legs of the letter A, without adequate provision of bridges below the apex.)

PLACE OF RESEARCH IN THE CONTROL OF INJURIOUS INSECTS*

By Prof. J. W. MUNRO

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It is well to remember that it is not necessary nor is it even practicable wholly to exterminate populations of injurious insects. For example, the Ministry of Agriculture has found that the growing of wheat on land carrying a population of wireworms of 600,000 per acre is economic, but on land carrying a higher population it is risky. It follows that if on heavily infested land the wireworm population could be reduced below 600,000 per acre the growing of wheat would be economical and for practical purposes control would be achieved.

As an example of the different kinds of work or investigation which the control of injurious insects entails I propose to take the control of insects affecting food-stuffs and other produce during transit and storage. These insects are, especially in wartime, a potential danger to the national economy, and methods of controlling them are only now being developed in Great Britain.

In 1929 I was asked by the Australian Dried Fruits Board to advise and assist them in dealing with infestation of sultanas and raisins by the phycitid moth *Plodia interpunctella*. The infestation occurred in these dried fruits on their arrival in London, and persisted and increased during storage in the warehouses prior to marketing.

The facts concerning this infestation and the measures which had then been taken to combat it were these. Infestation undoubtedly occurred in the drying and packing sheds of the fruit growers in Australia. It occurred in the packages of the fruit on shipment, and on the voyage from Australia to England became aggravated during the passage through the tropics. Measures were being taken in Australia to reduce infestation and, in Great Britain, a system of fumigation of all incoming fruit had been introduced. Cases of fruit arriving on shipboard in the Thames were transferred to barges for delivery to various warehouses up river, and all these cases were fumigated. A further step towards control was taken at that time by centralizing storage in a single group of warehouses instead of spreading it over many warehouses, and it seemed as if the prospect of control was promising. In 1929, however, it became evident that these measures were unavailing and it was then that I accepted responsibility for a review of the whole question of control to be practised in Great Britain and for the conduct of such investigations as might be necessary to ensure it.

A rapid survey of the conditions then prevailing showed that failure to achieve control was caused by the inefficiency of the fumigation of the fruit in barges and chambers, and it became necessary to investigate this. It soon became evident that fumigation practice was wholly empirical and that that could only be remedied by investigation of a number of problems. The more important of these concerned methods of determining the concentration of the gas obtained during the fumigation both in the air space of the barge or chamber and on and within the sultanas and raisins. Then came the need to study how a gas behaved during fumigation, to study the factors that affected its distribution and determined how much of the gas was adsorbed on the walls of the barge or chamber, on the fruit boxes and on the fruit itself, and how much was available after adsorption had taken place to perform the primary function of killing the insects. Then came other problems. It became necessary to ascertain for a number of fumigants what concentrations were required to kill the insects—caterpillars, chrysalides and moths in various stages of development and in different physiological states. For this experimental work it was necessary to rear large numbers of insects, and before much progress had been made with that, quite a number of problems of entomological interest arose, such as why some insects became sterile when reared at temperatures above 27° C. and why on some foods some species flourished better than others.

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* Substance of a discourse before the Royal Institution on December 18.

Already a wide field of investigation had become necessary involving work in physical chemistry and insect biology. Almost at the beginning of the physical chemical work on the behaviour of gases during fumigation, it became clear that mixtures of gases used as fumigants had obvious disadvantages. Such mixtures are used when the more toxic or active gas is inflammable or explosive and the purpose of the mixture is to reduce the risk of fire and explosion by using a non-inflammable gas as a blanketing agent. It soon became apparent that the failure of the fumigation system used by the Australian Dried Fruits Board lay in the use of a mixed fumigant. This fumigant was a mixture of carbon disulphide and carbon tetrachloride. Carbon disulphide is reasonably toxic, but inflammable and explosive. Carbon tetrachloride is poorly toxic to insects and non-inflammable.

The operator in charge of fumigation was, in fact, in a dilemma. If he made for safety against fire risk he was almost certain to fail to get a high percentage 'kill' of the insects. If he made for a high 'kill' he ran serious risk of fire and explosion. The practical result was that he had to risk survival of some insects because after one or two accidents he dared not risk more explosions. In doing this he allowed a population of insects to build itself up in the warehouses in which the fruit was stored after fumigation. We were not aware of that at the time. Meanwhile, we decided as a result of preliminary chemical work to recommend the abandonment of a mixed fumigant and the adoption of the simple fumigant ethylene oxide. After some experimental work in barges we secured a complete destruction of insects by using ethylene oxide, and the prospect of controlling Plodia in dried fruits looked good.

It was not until ethylene oxide had been in use for some time that we found that, even when we were certain all insects in the fruit had been destroyed, complaints were still made by merchants that the fruit they purchased was infested. Then we had to try to find out the defect in our new methods. There was no defect in our system of fumigation of fruit on arrival. The cause of continued complaints was that fruit was becoming re-infested during storage in the warehouse and this was a direct result of the failure of the mixed fumigant previously used. Here we were faced with a new practical problem. We had controlled insects in fruit during the transfer from shipboard to the wharf by fumigation in barges. We now had to control them in the warehouses. A series of rather costly experiments carried out showed that fumigation of large warehouses of 150,000 cubic feet capacity was at that time impracticable. Leakage was considerable and cost almost prohibitive. I then decided to try the use of a spray to kill caterpillars crawling on the fruit boxes and around walls and dunnage. That was not very promising. Then with some hesitation I decided on a rather bold experiment. A research student in my department was studying the rhythm of emergence of moths from their chrysalides. These moths showed a marked rhythm of emergence, leaving their chrysalides when the temperature of the day fell about dusk. It seemed possible that if the moths in the warehouse also showed such regularity we might be able to destroy them by spraying. The spraying of caterpillars on wares and walls failed because only those caterpillars which were exposed could be killed by the spray then in use, while large numbers hidden in cracks and crevices could not be reached. On the other hand, if by a systematic attack on the moths as they emerged from these cracks and crevices we could in time reduce their numbers below an economic level, control would be achieved. By sending up into the warehouse at dusk a fine spray of pyrethrum in oil we found we could kill large numbers of moths, and then the boldness of our strategy was rewarded by a wholly unexpected result. The mist sent up settled everywhere, forming a fine film of pyrethrum in oil, and this film proved fatal to caterpillars crawling over it. It was in fact so effective that in the following season we abandoned spraying at dusk and instituted a regular system of spraying in the daytime.

During three seasons in London and two seasons of this work in Bristol, Liverpool, Manchester and Glasgow we continued this combination of fumigation in barges and spraying in warehouses, and found then that we had successfully controlled infestation by Plodia.

Over the period 1930–35 the cost of laboratory research, experimental work at the docks, and actual control work at the docks was in round figures £30,000. In 1939 the saving effected as a result of the control measures devised had reached a value of £150,000. One further feature of this work deserves mention. Throughout the whole period of the work, both in the early stages when the work was experimental and in the later stages when it became routine practice, there was the fullest confidence and co-operation between the research workers and the officers of the Australian Dried Fruits Board.

In the course of our laboratory investigations we were acquiring knowledge of the behaviour of fumigants and of the principles underlying fumigation; we were also acquiring much knowledge of the habits and biology of insects. The work done on fumigants may readily be divided into large-scale experimental work at the London docks and laboratory experimental work. The first concerned the application of fumigants to ships and warehouses and dealt with such problems as the measurement of gas concentrations during fumigation; the distribution of the gases ethylene oxide and hydrogen cyanide in empty warehouses, the effects of different methods of stacking or piling goods on the distribution of these gases in barges and warehouses, and the various means by which distribution could be improved by using vaporizers and fans.

The laboratory work dealt with the determination of fumigants. First, methods of determination were devised, and then the amounts of gas remaining in various food products were determined. This work was of high importance because it afforded the means for ascertaining how far various fumigants could be used with safety on various foods under varying conditions, what residues were left in the foods and what measures were required to reduce these residues to the lowest level. The results of all this work have recently been summarized and published by the Department of Scientific and Industrial Research as a pamphlet, under the title "The Principles and Practice of Fumigation".

The biological work done may also be divided into field work carried out at the London docks and laboratory work. The field work comprised studies of the life-histories and habits of various insects living in warehouses, and studies of the effect of sprays and fumigants on the populations of these insects. Laboratory work dealt with the factors affecting insect fertility both during development and in the adult stages. Systematic revision of groups or genera of the most important insects infesting foodstuffs was undertaken, notably a revision of the moths of the genera Ephestia and Plodia. Other subjects studied were the resistance of insects to high temperature, the experimental analysis of the factors governing the hours of emergence of insects from their pupæ, the nutritional requirements of important species, and certain aspects of respiration. Then came various studies of the toxicity of fumigants, ethylene oxide, hydrogen cyanide and sulphur dioxide, and of various contact insecticides such as pyrethrum and the thiocyanates.

In 1937 a small beetle belonging to the family Ptinidæ, or spider beetles, appeared in the fruit warehouses and caused considerable concern. The chief cause of this was that, unlike *Plodia interpunctella*, this beetle was not very susceptible to our Pyrethrum insecticide. This new problem, together with others which had arisen both in our chemical and in our biological work, clearly showed the need to extend our scientific work to include insect physiology, and the most cogent argument for that lay in the part knowledge of physiology could play in giving us a better understanding of our insecticide problems. So, with the assistance of the Agricultural Research Council, we embarked on physiological work, and because the insecticides (fumigants and sprays) with which we were concerned had to act through the skin or cuticle of the insect, it seemed reasonable to begin with a study of the insect cuticle and its bearing on the mode of action of insecticides. The work undertaken was broadly considered under three main heads: a study of the changes occurring in the cuticle during growth of the insect, a study of the biochemistry of the cuticle, and a study of the lesions produced in various organs or tissues when the insecticide had penetrated the cuticle.

Meanwhile our practical work on the control of insects infesting dried fruits had ceased and I was concerned with another practical problem, the control of the bed-bug. That work was being undertaken on behalf of the Medical Research Council, and in the course of it a fraction of heavy naphtha as produced in gas works was examined as a potential insecticide. This heavy naphtha comprised a number of constituents: indene, pseudocumene, coumarone and paraffins. Of these it was thought pseudocumene would be the most insecticidal, and in particular it was taken for granted that the paraffins were inactive and were in fact unwanted diluents. On this assumption it was decided to eliminate the paraffins, but when this was done the toxicity or insecticidal value of the heavy naphtha fell markedly and some of the paraffins had to be restored. After some further work the practical use of heavy naphtha against the bed-bug was made possible and the work on it ceased. Meanwhile, the interesting scientific problem of the part played by the apparently inert and relatively non-toxic paraffins remained, and by means of a grant from the Department of Scientific and Industrial Research the problem was studied further by investigating the permeability of the insect cuticle, again as an aid to the understanding of the mode of action of insecticides. This investigation had not gone far when it became evident that the really fundamental questions to be answered lay in the realm of surface physics and colloid chemistry, and again the scope of our scientific work was extended.

With that broad but unavoidably confused sketch of the relationship between the practical problem of controlling injurious insects and the laboratory investigations which are essential to its solution, I think we can now consider the place of research in entomological practice. The following items of experience gained in this work deserve notice because they illustrate three fundamental principles in applied entomology. First, that the way to tackle a practical problem is to get right down to it. When that is done the scientific problem becomes clearer. Second, that the research necessary for the solution of practical problems can only be defined when both research and practice keep in the closest touch with one another. In so young a science as biology applied in fields other than medicine it is idle to suppose that research basic to agriculture or to industry or to public health can be planned within the four walls of a laboratory. Third, that the scientific work required for the solution of practical problems cannot be confined by any doctrinaire or academic definition of the branch or branches of science in which it lies. The fact that a practitioner is a zoologist or an entomologist by training is no excuse for his failing to follow his work into chemistry or physics if that is necessary.

I should like to stress these points because recent experience in dealing with war-time problems has itself stressed them. The practical work on fumigation and on the use of pyrethrum-in-oil films carried out in controlling insects infesting dried fruits forms the basis of the extensive control of insects affecting foodstuffs now practised by the Infestation Control Branch of the Ministry of Food. All the fields of research opened up in attaining the control of the moth *Plodia interpunctella* are now being worked in and extended by the recently established Pest Infestation Laboratory of the Department of Scientific and Industrial Research, and it is, I think, significant that the most recent development of all, the investigation of the factors affecting the passage of insecticides through the insect cuticle, offers reasonable promise that it may before very long provide a means of greatly saving insecticide materials. These are now, as a result of the war, 'in short supply' and urgently needed not only for the protection of growing crops and of food in store but even more for the control of flies, mosquitoes and other insect vectors of disease which are so important a factor on all the fronts on which we are now fighting.

Experience in the last three years has stressed another important feature of insect control work. In spite of the great extension of practice and of the greatly increased tempo of research and particularly of what is called short-term or *ad hoc* research, it is the long-term or basic research which is paying the highest dividends in practical results. This may seem paradoxical. The objectives of short-term or *ad hoc* research are those thought to be within reasonably easy reach, and the research itself usually covers a severely restricted field. The objectives of basic or long-term research are usually distant and the research itself is nearly always planned on a broad basis. It is precisely this planning on a broad basis that makes it valuable not only in science but also in practice, and in the light of the experience of the last three years I am almost tempted to believe that if provision is made for long-range research on a broad basis in which the closest contact is maintained with practice, much of the *ad hoc* work carried out in relation to the control of injurious insects might be dispensed with. That may, however, be to simplify matters too much, because there is often a gap between basic research and practice which can only be filled by *ad hoc* work. On the other hand, my own experience strongly suggests that it might be better if this necessary *ad hoc* work were carried out jointly by the practitioners and the research workers.

In recent years in applied entomology there has grown up a kind of investigation commonly called *ad hoc* research which has in my opinion little value. It is the kind of work which assumes that any kind of investigation, because it relates to an injurious insect or to the use of insecticides, is *ipso facto* of economic or applied scientific value. The literature of economic entomology is overburdened with accounts of work of that kind almost to the despair of the serious research worker and of the practitioner alike, because the work described is too often neither good science nor good practice. The possibility that in economic as in scientific work the discovery of new laws and principles may solve a problem cannot be overlooked, and in seeking to discover new laws and principles relating to insect behaviour or to the mode of action of insecticides it may be the simpler, if not the only, approach to study quite other insects than the injurious ones and then, having gained an understanding of principles, apply these principles to the solution of the practical problem.

I refer to this misunderstanding of research in applied entomology because recent experience has thrown it into high relief, and because the same experience has emphasized the value of a background of research as free and untrammelled by immediately practical considerations as is possible in a workaday world.

I favour, then, the freest basic research in the closest contact with practice, but I often meet with the view that free research aimed at the discovery of new laws and principles is incompatible with practice; that it is impracticable in war-time; that research and practice cannot run in double harness, and that their aims are totally different. That their aims may be different I do not for a moment deny, but that they are incompatible is demonstrably untrue.

So it comes about that in this field of work in the control of injurious insects there is and must be a continuous going to and fro between practice and research and between research and practice. They are not incompatible; they are complementary, and it may be some compensation for the sorrow and tragedy of war if in this and in other fields fundamental research and practice can continue to work together.

MUSEUMS AND EDUCATION

By G. F. WESTCOTT

Science Museum, South Kensington, London

THE present world upheaval is partly due to the fact that man's control over his physical environment has advanced rapidly, while the ideas and methods which he uses for controlling his relations with his fellows have developed much more slowly.

One of the most important psychological features of man is his emotional and habit-forming nature. This nature has been essential to the development of civilization, by enabling the individuals of a nation to act together as a community with a common purpose. It is particularly valuable when reasoning cannot be used, whether for lack of intelligence or time or when the amount of evidence available to all is insufficient to produce logically a reasonable uniformity of opinion. No human being can be logical all the time: we all use many ideas, obtained by habit or suggestion or by previous reasoning, which are frequently emotionally reinforced and have become practically impervious to reason or suggestion in normal conditions. These ideas are often the guiding principles of our lives, which enable us to act quickly and help to give us our characters. They simplify our lives and save us from becoming choked by logical entanglements. It is an example of the small part reason plays in human life that these most fundamental ideas, particularly liable to emotional reinforcement, have received the least amount of study by scientific methods.

In the past, poor communications and the strong influence of tradition have been safeguards against the sudden rise over a large area of a new system of ideas. But to-day there is a loss of faith in tradition and, as we have seen only too clearly, the tremendous developments in our methods of communication and propaganda, especially when combined with repression and the destruction of all opposition (which can also now be organized and applied rapidly over a wide area), can change the purpose of a nation in a very short time, with disastrous results to the whole world. Emotions are so strong that they can be acted upon to reinforce almost any idea, whether right or wrong, and even against the balance of direct evidence. Repeated propaganda, especially if contradictions are suppressed, can also be used to form mental habits and so strengthen particular ideas.

In the past there has been a number of ideologies, sometimes on a national basis, and competition between them may have tended to ensure the survival of the fittest, even though this may often have meant mainly the ability to destroy its rivals by force or subterfuge; but the world seems to be approaching a time when, at least in certain directions, there may be only a few generally accepted views. It is essential, if development is not to be retarded, to provide for constant criticism and research, so that the best ideas may have a chance of coming into use. Perhaps a practical objective science of ideas and thought will be developed as a safeguard—indeed, work has already been done on these lines. This would result in further mental instruments being devised to enable man to transcend his natural abilities.

A practical ideology must satisfy at least two conditions: it must be expressed in such a way that it will communicate at least some acceptable meaning to many of the individuals concerned, and it must be sufficiently in touch with reality on essential points to be workable. Many of the most important ideas on which our present civilization has been built, especially in the moral and political spheres, are upheld by the authority of tradition. This, owing to its strong power of resisting change, has probably provided the stability needed for the development of civilization in other directions. Tradition, however, in these spheres seems to be losing its power and also appears to be too resistant to change to keep pace with modern events, leading to the danger and actual occurrence of revolutions based on the authority of dominating individuals using all the modern methods of mass influence. It would be disastrous if civilization were to be left to the control of such ephemeral and fortuitous authorities, and it seems clear that there is an urgent need for some new kind of authority, more universal and stable and capable of rapid adaptation to new factors in the situation as they occur. The position is perhaps similar to that of several centuries ago, when the authority of tradition began to give way to the authority of knowledge based on experiment in the domain of the physical sciences. The rapid advances which have been made in science are mainly due to the use of methods which largely eliminate the effects of emotion, habit and prejudice; if we are to advance quickly and safely in the moral sphere, I believe we must use similar methods.

At the present time it may still be expedient that our conduct and ethical ideas should be guided largely by tradition, to prevent confusion and rash experiments, but I think that with an adequate historical background there would be little danger of trouble occurring even if people should be encouraged to think logically for themselves on such subjects. In the absence of emotional reinforcement the position would be similar to that in science, where a new idea, even if truer than previous ideas, meets with great opposition until it has been thoroughly tried out and assimilated into the main body of accepted theory.

The evidence on moral and political subjects obtained and presented by scientific methods is steadily increasing and may soon be sufficient to ensure a reasonable uniformity of educated opinion, if made readily available to all adults. Particularly since the beginning of the present century, new ideas and methods have been introduced into psychology and, though as yet psychology is apt to be regarded more as an art than a science and there is much conflict of ideas still to be resolved, our knowledge of human conduct has been considerably increased. The time is not far distant when our knowledge of how men do act will greatly influence our views as to how they should act. Such an ethic would increase our understanding and sympathy for others, whether nations, races or individuals.

It seems essential, especially if democracy is to survive and produce the best results, that as many people as possible should be taught how to think for themselves, and how to protect themselves from emotional exploitation for false or evil purposes. The individual must become more critical; though fortunately he cannot escape his emotional nature, and thus deprive life of much of its interest and drive, he can do his best to ensure that his feelings shall only be used to reinforce ideas, and particularly innovations, which conform with the best evidence available.

I would suggest that, among the objects of education in a democracy, the following are important:

(1) To provide the individual with a reasonably stable and dependable background for his mental development.

(2) To teach him how to think for himself and how to obtain reliable data, and to encourage him to use reasonable criticism and constant research.

(3) To help him to learn how to use his emotions and how to guard himself against their misuse by others.

(4) To discover and develop his abilities, so that he may become a useful member of the community.

Museums as an Educational Medium

In this particular connexion let us consider our national museums. The four selected objects are of the kind for which museums could be of the greatest assistance, and the following indicate some of the ways in which museums could help to attain these objects.

(1) For the later mental development of the individual a historical background is the most universal and stable. A knowledge of the past is a great help in understanding and dealing with the present and preparing for the future. Museums, by preserving the physical evidences of the past and by orderly arrangement, can do much to provide a common historical background.

(2) By examining examples of the work of men of the past, of the triumphs of critical thinkers and of scientific research, the visitor to a museum is bound to be impressed by the value of these methods and may be encouraged to try to use them himself. Museums and their associated public libraries would themselves be one of the sources of reliable data.

(3) Museums at the present time only help towards obtaining emotional control indirectly; for example, by inference from the insight they give into historical processes. To be more effective (*a*) there should be a museum (or part of a museum) devoted to psychology, and (*b*) an attempt should be made in museums generally to illustrate the influence of widespread (and consequently often emotionally reinforced) ideas on the development of civilization, so as to show which have produced permanent and which relatively fleeting effects. The evidential material thus made available in an interesting way would provide a stable background for judging the value of ideas.

The opportunity afforded by museums for studying the actual evidence on which authorities have based their theories, and the illustrations of the methods used to develop our understanding of the universe should help to produce a more rational attitude towards authority in general. Though we cannot be expert on all subjects, we can carefully examine the evidence in some small selected part of the field of knowledge and so obtain a better understanding of the foundations on which authority rests, particularly in the domains of science and history.

(4) By covering the whole field of man's thought, knowledge and activities, museums could help to discover to the individual (and his teacher) any particular interests or abilities which he may possess, and so enable him to decide in what way he could best serve the community and himself—that is to say, stimulate education rather than inject instruction.

Advantages of National Museums

Museums, especially the national museums, have advantages from an educational point of view over local teaching establishments in some respects. For example, they contain unique examples of historical and evidential value; their material can be made to appeal to nearly all the human senses, and thus be made more interesting; expenses can be incurred for special exhibits which would be beyond the means of every local school or college; they can cover nearly the whole field of human knowledge and endeavour. As the educational possibilities of museums become more generally recognized, the time may come when visits to them will be included in the experience of all individuals (perhaps specially arranged tours to cover several weeks). The organization and display of museums would be adapted to increase their educational value.

One can visualize the time when the national museums will be organized to cover all the branches of knowledge systematically. For example, there would be a museum or museums illustrating what may roughly be defined as "Man's methods of dealing with himself and with his fellow men": this might include such subjects as government, laws, customs, warfare, religions, philosophies, education, psychology, physiology, anatomy and medicine.

These museums would deal with their particular subjects fairly fully and contain as much as possible of the important actual evidence available, such as historical relics. Descriptive labels would be attached to each exhibit: these should include sources of evidence and appropriate cross-references, and thus encourage the visitor to further research and self-education. Exhibits representing recent advances in our knowledge in the present or of the past would be brought particularly to the visitor's notice; in fact, it would be to museums that the public would naturally go for the latest information on such subjects.

Special Museums

In addition to these national museums dealing with limited and specialized subjects, I think there is another type of museum which would be of great educational value. This would deal with the development of civilization in general and as a whole, and form an introduction to, and a link between, the national museums. It would be integrative, and in it an attempt would be made to make the past live again. The ideas, politics, social organization, arts, crafts, and sciences, etc., of the past would be combined. It would be impossible to show the complete story of the development of civilization in the world as a continuous process, and so only certain important phases would be selected for treatment. For example, for a museum in Great Britain, a selection of periods such as the following might be made: early Egyptian; early Greek; Roman; Europe in Dark Ages; Italian Renaissance; and then, say, three periods of English history. The final period would be outside the museum—the actual present world. Of course, the periods, if thought desirable, could be extended backward in time to prehistoric eras.

In this museum actual relics of the periods would not normally be shown (unless large numbers in good condition happened to be available), but the reconstructions would be made as accurately as possible on the available evidence. Great care would be taken to provide suitable explanatory labels. Such a museum would not claim to represent final truth, but merely to be a careful attempt to reconstruct the past. It would invite criticism and would, of course, be modified as new evidence came to light. Possibly, in suitable cases, the staff might be dressed in the costumes of the periods illustrated, and other means of adding realism adopted.

Mental instruments and methods have developed as well as material instruments, and it is most important to bring this out. Lecture theatres, cinemas and stages, where plays illustrating the life and ideas and demonstrations of the arts and crafts and instruments of the past could be given, might form an important part of the museum. There might also be rooms devoted to the great philosophers, and their philosophies, which influenced the periods concerned.

OBITUARIES

Dr. Cyril Crossland

By the death of Dr. Cyril Crossland on January 7 at Copenhagen at the age of sixty-four, zoology has lost one of its last explorer-naturalists of the Darwin type. He was educated in the Lake District, where his father was a well-known lake painter. During his whole life he suffered from deafness, but this did not prevent him from becoming a personality in Clare College, Cambridge, where he compelled its steward to provide vegetarian meals for him and his numerous disciples.

Wanting an assistant for his researches on the naked Mollusca, Sir Charles Eliot, Consul General and Commissioner, took Crossland to East Africa, where he developed a taste for small boat sailing, which enabled him to explore the coasts of Zanzibar, Pemba and the adjacent mainland. He compared the barrier reefs off the latter with those described by Darwin off Brazil, both series being formed by erosion. Zanzibar proved to be an enlarged portion of the continental barrier, whereas Pemba was an independent elevation; the coastal flats of the whole area were due to a recent lowering of sea-level. No reefs were found that could be considered as due to growth *in situ*. For comparison, he next visited the Azores, having been appointed fellow of the University of St. Andrews, discovering well-consolidated Dendrophyllia, Vermetus and Lithothamnion coastal formations.

In 1904, Crossland proceeded to the Red Sea on a year's biological exploration, in which he covered about five hundred miles of its western coast, collecting all the time. "Its shores are all composed of elevated coral and are fringed with its luxuriant growth, while Barrier and other reefs and patches fill the sea for miles from either shore." The Sudan was being opened up by the development of Port Sudan, and Crossland was given a commission for the economic culture of shell oysters, being allowed a free hand. He ran a farm for the next fifteen years at Donganab, about sixty miles north of Port Sudan, off which there was a maze of surface reefs and submerged banks with clear water between. Here he built a patriarchal settlement for his fishermen and he became a source of supply for Red Sea animals to nearly every school of zoology and museum in Europe. In 1913 he published his "Desert and Water Gardens of the Red Sea", descriptive of the lives of his people and reefs and of the sides of his fault line, more than 1,500 miles linearly of coral reef. In the War of 1914–18 his settlement was useful in policing the Red Sea, and his oyster farm was producing a crop of millions, for he had succeeded, where all his predecessors had failed, in breeding his oysters, laying their spat and protecting their shells. Meantime, the market for pearl shell had gone, Vienna, its chief user, being almost a city of the dead, and he himself driven to hawking his shells where he could. Donganab was abandoned and Crossland came back to England.

During the next twenty years, Crossland used Cambridge as his home base, writing many papers on his collections, those on the chætopods in a class by themselves. There came next that curious expedition on the sailing yacht *St. George*, which anyone could join, each "going as he pleased". He wrote admirable accounts of the calm and muddy seas off Panama and of the fresh volcanic slopes of the Galapagos. In the older bays of the Marquesas corals tried to build in a singularly barren region. He left the ship at Tahiti, where he settled on its coasts for a year, to study its highly developed reefs and a luxuriant fauna, the most easterly outlier of Malaya. The surrounds of Tahiti, Mocrea and later Rarotonga were compared to those of other regions, with striking results. Basaltic stones were found lying in the reef surfaces or bedded in the rock below. The reefs are going back rather than extending seawards, and in extreme cases appear as submerged banks. The lagoons were formed by the hollowing out of an originally continuous reef. These important conclusions were followed by a close study of the corals, on which he was still engaged up to the time of his death.

Crossland, however, was called from retirement once again to go to the Red Sea, being commissioned by the Egyptian Government to found a biological station at Ghardaqa, off the mouth of the Gulf of Suez. Like everything else, he did this well, the facilities for keeping living organisms being excellent. He explored the deep waters of the Gulf of Akaba and of the Red Sea off the same. To-day his station is a flourishing institution and Dr. Gohar, its director, generously extends its hospitality to Western workers.

In many respects Crossland was a most attractive person. He enthused everyone with whom he came into contact, this extending to his native labour wherever he was. His published researches number about forty and are characterized by their original, often unorthodox, outlook. They demand the study of all who are concerned with biological and faunistic research in the tropics. His deafness was a tragedy, for it prevented that personal contact with his fellows so valuable to research workers. J. S. GARDINER.

Dr. Alexander Russell, F.R.S.

DR. ALEXANDER RUSSELL, advisory principal and governor of Faraday House College, died at his home at Mill Hill on January 14.

Dr. Russell was born at Ayr in 1861 and graduated at the University of Glasgow with first-class honours in mathematics and natural science. In 1882 he went to Caius College, Cambridge, and became a wrangler in 1886. He was for a time mathematical lecturer at Caius, and afterwards mathematical master at Cheltenham College and then at the Oxford Military College.

In 1890 Dr. Russell joined the staff of Faraday House, so that he was associated with it practically from the beginning. He became principal in 1909 and remained in this position until 1939, when he became advisory principal, leaving the more active work to a younger man. It was during these thirty years that he built up the college and its reputation, so that the name of Faraday House is always linked with his and can never be dissociated as long as it exists. No successor can take his place.

Many honours came to Dr. Russell during that time. He was awarded the D.Sc. by his old University of Glasgow in 1908 and in 1924 the LL.D. He was elected president of the Institution of Electrical Engineers in 1925 and had been president of the Physical Society and vice-president of the Institute of Physics, and nominated an electrical inspector by the Electricity Commissioners. He was elected to the Royal Society in 1924 and finally in 1940 he was awarded the Faraday Medal of the Institution of Electrical Engineers. There have been only eighteen recipients of this medal since its foundation, and among them are such famous names as Sir Oliver Lodge, Lord Rutherford, and Sir William Bragg.

Dr. Russell had been a pupil of Lord Kelvin, who had been a friend of Faraday, so that an authentic link was preserved, through him, with the pioneer of practical electricity.

Dr. Russell was fortunate in being known in the electrical world in the early days of the practical application of alternating currents and was able to apply his mathematical knowledge to the problems that they raised. His two books, "Alternating Currents" and "Theory of Cables", became standards, and the method he invented for computing the mean horizontal candle-power of a lamp is still called the "Russell angles". He was a most industrious writer and produced a life of Lord Kelvin as well as many papers communicated to the Royal Society, the Physical Society and the Institution of Electrical Engineers. For many years he was a frequent contributor to NATURE.

One of Dr. Russell's great interests was lightning and atmospheric electricity, but during his latter years he became absorbed in the theory of numbers.

In the early days of television, Dr. Russell took a party of engineers to Baird's early studio in St. Martin's Lane. It was suggested that an attempt should be made to transmit a human face, and Dr. Russell was selected for the experiment. It has, therefore, been claimed that he was the first man to be televized, but complete confirmation of this fact is lacking.

Many hundreds of old students of Faraday House College, now scattered all over the world and in the Services, will remember Dr. Russell by his kindness and helpfulness to all who came to him. This is the truest and most lasting memorial to the memory of a great man. W. R. C. COODE-ADAMS.

Prof. R. G. Collingwood, F.B.A.

PROF. ROBIN GEORGE COLLINGWOOD, archæologist, historian, and philosopher, originally acquired his artistic and scholarly tastes from his father, W. G. Collingwood, the friend and biographer of Ruskin, and his Jewish mother. He early became an omnivorous reader and an adept linguist, and thus laid the foundations of the almost universal learning which was the surprise and delight of his friends in conversation. In boyhood, too, he learnt how to use his hands in playing the piano and violin, in draughtsmanship, and in sailing a boat (always a favourite recreation), and he thus acquired the manual dexterity which was later a prominent characteristic, evidenced, for example, in toys he made for his children and in his beautiful handwriting.

At Oxford he came under the influence of Haverfield, who deepened the interest in Roman Britain which he had already caught from his father. But philosophy claimed him, and it was a philosophical fellowship to which he was elected at Pembroke College in 1912. Always too absorbed in his studies to have much time for social distractions, he had comparatively few close friends, although his attachment to those he had, like theirs to him, was deep and lasting. No less enduring was the regard of his pupils, for on them he lavished the resources of his vigorous and original mind, placing philosophical problems in their historical context and illuminating them with his extraordinary power of graphic exposition.

During his years at Pembroke he was working equally strenuously at excavating Roman sites, collecting inscriptions, and re-interpreting the history of Roman Britain. His work in these fields was recorded in a long series of publications, culminating in "The Archæology of Roman Britain" and, finally in the first volume of the "Oxford History of England", on which his fame as an historian securely rests. It was as much for his historical as for his philosophical work that he was elected a fellow of the British Academy and given the honorary degree of LL.D. at St. Andrews.

In philosophy his aim was to persuade philosophers that history was as important for their investigations as physical science. In this aim his work is meeting with some success, although his own philosophy has not yet been so widely accepted as his history. His standing as a philosopher will probably rest ultimately on his "Essay on Philosophical Method"; his later books, "The Principles of Art", "An Essay on Metaphysics", and "The New Leviathan", all contain original thinking of the highest order, and they are written with a lucidity and verve uncommon in philosophical works, but they lack the finish of the earlier book, and over parts of them there hangs the shadow of his increasing ill-health.

Insomnia and overwork had begun to undermine his strength even before he became Waynflete professor of metaphysical philosophy at Oxford in 1935; and the hope that his new office, by easing his teaching burden, might enable him to recuperate and to expound his own philosophy *in extenso* was only partially fulfilled. After a serious breakdown in 1938 he fought a steadily losing battle; in 1941, when he could no longer both lecture and write, he chose to resign his chair. But there was no recovery, and he died on January 9 at the comparatively early age of fifty-three, mourned by his friends as a lovable personality, by scholars in general as one whose contributions to learning have substance and permanent worth.

T. M. KNOX.

WE regret to announce the following deaths:

Sir Robert Armstrong-Jones, C.B.E., consulting physician in psychological medicine at St. Bartholomew's Hospital, formerly general secretary and later president of the Medico-Psychological Association, on January 30, aged eighty-five.

Prof. C. C. Farr, F.R.S., emeritus professor of physics in Canterbury College, Christchurch, New Zealand, aged seventy-six.

Dr. F. S. Sinnatt, C.B., M.B.E., F.R.S., director of fuel research, Department of Scientific and Industrial Research, on January 27, aged sixty-two.

NEWS and VIEWS

Geological Society Awards

THE Council of the Geological Society has made the following awards: Wollaston Medal to Prof. A. E. Fersman in recognition of his fundamental contributions in the field of geochemistry and his researches on the economic mineralogy of Russia; Murchison Medal to Prof. A. Brammall for his notable contributions to geochemistry and petrogenesis, especially of the rocks of Dartmoor and Malvern; Lyell Medal to Mr. D. N. Wadia, lately of the Geological Survey of India, for his work on the syntaxis of the Himalaya and his contributions to the geology of India, especially Kashmir; Bigsby Medal to Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, for his geological studies on Persia, Oman and his important share in the discovery of oil in England; Wollaston Fund to Miss Ethel D. Currie in recognition of her valuable researches in palæontology; Murchison Fund to Mr. A. G. Davis for his work on the Cretaceous and Tertiary fossils of south-eastern England; one moiety of the Lyell Fund to Mr. F. A. Bannister and another moiety to Dr. M. H. Hey, for their joint X-ray and chemical investigation of minerals.

Highway Engineering at the University of the Witwatersrand

DR. BERNARD H. KNIGHT, research officer in highway engineering in the University of the Witwatersrand, Johannesburg, has been appointed to the newly created chair of highway engineering in that University, with effect from April 1 next. It is believed that this chair of highway engineering, which is tenable in the Department of Civil Engineering, is the first of its kind to be founded in the British Empire outside Great Britain. Its establishment has been made possible by the joint support of the South African Iron and Steel Corporation and the National Road Board. Dr. Knight, who was formerly lecturer in road engineering at the College of Estate Management, London, was appointed senior research assistant in highway engineering at the University of the Witwatersrand early in 1939. Since then, three postgraduate scholarships in highway engineering have been established in its Department of Civil Engineering. The marked development in highway engineering research which has taken place at this University has been made possible by the provision of the new Civil Engineering Laboratories situated in the Hillman Building, which was officially opened by the Prime Minister of the Union of South Africa, General Smuts, in June, 1941.

Science Students and Industrial Experience

THE War is undoubtedly speeding up many changes in our educational habits. Until quite recently, it was the custom for students of engineering only, either during vacation or otherwise, to spend some part of their time in the practice of engineering on the industrial side. The needs of total war have brought out something that has always been latent in every branch of science, namely, its close linkage at some point with industrial practice, either on the side of production or of technological research. It is not surprising, therefore, that students in pure and in applied science, in addition to those in engineering proper, should seek the opportunity of adding to their experience by taking part in industrial life when the opportunity presents itself. This is underlined in the recent report, for the year ending October, 1942, on the vacation apprenticeship scheme in operation at the Imperial College of Science and Technology. The scheme is sponsored by the Imperial College Union, and is under the chairmanship of Prof. H. Levy, representing the governing body.

During the past year, 340 students have spent on the average nearly six weeks in research departments and in works, assisting with special investigations, studying the productive processes and the schemes of organization. Some 170 of the foremost firms of Great Britain and many Government departments have willingly co-operated with the Committee in this venture, and have been sufficiently interested to write reports on progress. The scheme has been extended to cover intending students in the summer vacation prior to entry, provided they have reached the Intermediate B.Sc. standard. Last year 32 students entered the scheme at this stage. Apart from the financial return to the students themselves, it is clear that this will give them experience that must react very favourably on their capacity to assimilate the more theoretical studies with which they are necessarily concerned at college; and the fact that the proportion of students of chemistry, physics and mathematics availing themselves of the opportunity presented is steadily increasing is an indication that the scheme meets a real need. Its educational consequences will be well worth watching.

Government Grant to Universities

Sir Kingsley Wood, Chancellor of the Exchequer, has announced, in the form of a written reply to a question by Sir E. Graham-Little, the Government's policy with regard to financial support of the universities of Great Britain. He said that, although the impact of the War on university finance has so far been less severe than was expected, the Government has maintained unchanged the annual provision for university grants at £2,149,000. This policy was adopted in view of the vital part played by the universities in the life of the country, their essential contributions towards the national effort in war-time, and the prospect that immediately after the War they will be faced with very large demands on their funds in order to resume normal activities. These considerations have lost none of their force, and the Government, after considering a report from the University Grants Committee, has again decided to maintain the provision at its existing level.

Swedish Forest Products

According to the Swedish International Press Bureau, a survey of Sweden's production of forest products of a chemical nature was recently given by Mr. Otto Cyren, director of the Swedish Chemical Office. Speaking of chemical pulp, one of Sweden's most outstanding export products in normal times, he said that Sweden is in a very good position in respect of quality, as the slowly growing timber in northerly regions gives very long fibres, and consequently the strongest pulp and paper are obtained from it. The most important by-product of the sulphite pulp production is sulphite spirit, which up to most recent years was the only product recovered. Mixed with petrol, it was of importance as a motor fuel. The purity of the rectified spirit now surpasses that obtained from grain and potatoes, and it is therefore used also for human consumption. Researches on the possibility of using sulphite spirit as the basis of more highly developed products were not initiated until the present crisis made the matter urgent. As an instance he described the work carried on by the Mo and Domsjo Company. In 1941 this company completed a factory for the production of sulphite spirit with a capacity for 10 million litres of 95 per cent spirit a year. At this factory intensive research work is going on, with the view of producing various synthetic products from the spirit. From the black lye obtained in the sulphite pulp process there are produced *inter alia* certain crude acids, the first factory for using this raw product having been built at the Bergvik och Ala pulp mill. The sebacic acid produced here, called 'pine fatty acid', is used to replace fat in washing mediums, as a substitute for linseed oil in paints, etc.

The output of charcoal in Sweden has trebled in the last couple of years, mainly due to the extensive producer-gas traction of motor-cars, and the by-products from the carbonization are now being recovered more carefully than before. The charring of old tree stumps, with their high content of rosin, alone gives about 20,000 tons of tar a year. Wood tar is now used as motor fuel for fishing boats in place of crude oil, and has probably saved the Swedish high-sea fisheries from total stoppage. It is also used for the production of lubricants. In summing up the situation for the Swedish forest products industry, Mr. Cyren stated that in 1941 the Swedish exports of woodstuffs had declined by about one third, and the pulp and paper by two thirds, compared with the pre-war level. But in compensation the forests, by supplying cattle feed, wood fuel, motor fuel, lubricants, textile material, fatty oils, and a good many other useful products, have saved the country from catastrophe.

Variation in δ Ursæ Majoris

Mr. F. M. Holborn suspected at the end of August that this star was fainter than usual, and this suspicion has since been confirmed by Mr. N. F. Knight, who observed it in North Africa. His latest estimate of its magnitude on December 10 was 3·8–3·9, and on January 14 and 15 Mr. Holborn found that its magnitude was 3·7 (normal mag. 3·4).

Announcements

The following appointments in the Colonial Service have recently been made: H. B. N. Hynes, entomologist, Kenya; G. R. Groves (horticulturist, Bermuda), curator of the Botanical Gardens, British Guiana.

Dr. G. M. B. Dobson's discourse at the Royal Institution on February 12 on "The Air we breathe in Town and Country" will deal with the results of the survey by the Department of Scientific and Industrial Research of the air pollution of Leicester. This was the first detailed survey of the kind ever undertaken in Great Britain. The scientific officer in charge at Leicester was Dr. A. R. Meetham, who was responsible for carrying out the work there.

LETTERS TO THE EDITORS

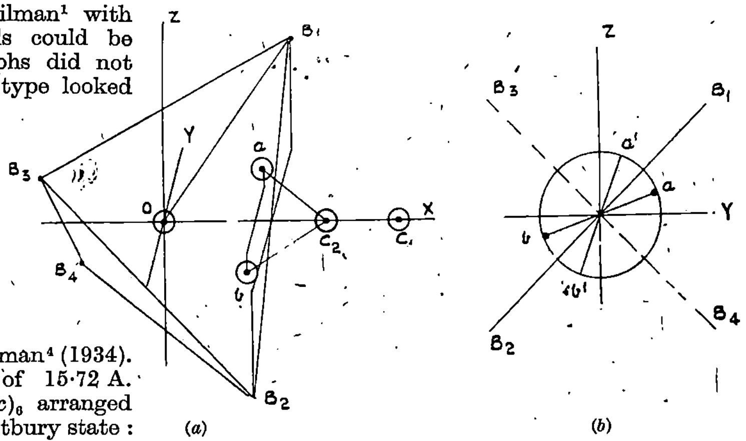
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Change of Symmetry with Temperature

During the course of an investigation into the effect of temperature on X-ray reflexion in crystals, some photographs were taken of basic beryllium acetate to see whether any of the diffuse reflexions observed by Charlesby, Finch and Wilman[1] with electron diffraction in organic crystals could be detected with X-rays. The photographs did not show with certainty any effect of the type looked for, but another effect was observed. At the time (1939), we did not think the matter of very great importance, but recently the results were shown here to Prof. W. T. Astbury, who suggested that they were of sufficient interest to deserve recording.

The structure of basic beryllium acetate has been described by Bragg and Morgan[2] (1923), by Morgan and Astbury[3] (1926) and by Pauling and Sherman[4] (1934). The crystal is cubic and the unit, of 15·72 A. edge, contains eight molecules OBe$_4$(*Ac*)$_6$ arranged in a 'diamond' structure. Morgan and Astbury state: "The unique oxygen atom lies at the centre of a regular tehrahedron of beryllium atoms, while the six equivalent acetate groups are associated with the edges of the tetrahedron. Each acetate group is symmetrical about a dyad axis, that is, its two oxygen atoms are equivalent and the three-fold symmetry of the (CH$_3$) group is for some reason non-effective. The plane of each acetate group, since full tetrahedral symmetry does not extend beyond the tetrahedron of beryllium atoms, must lie oblique to the tetrahedron edge with which it is associated." The positions of the oxygen atoms have been determined by Pauling and Sherman.

The obliquity of the plane of the acetate atoms to the edge of the tetrahedron of beryllium atoms is inferred from a lack of symmetry in Laue photographs taken with the X-ray beam parallel to a [111] direction. As may be seen in Fig. 1 (left) the pattern is not symmetrical about the lines *AA'*, *BB'*, *CC'*, having only simple threefold symmetry when examined at room temperature. However, if the temperature is raised to 100° C. the picture, Fig. 1 (right) becomes symmetrical about the lines *AA'*, *BB'*, *CC'*, and resembles the Laue photograph to be expected from a crystal with holohedral symmetry. The change to this holohedral type of pattern takes place between 30° and 50° C.



(*a*) (*b*)

Fig. 2.

Fig. 1 (right). A few of the weaker Laue spots disappear as the temperature rises, but apart from this (and the intensity changes which produce symmetry) the pattern does not alter in any radical way, so that the change is not to be ascribed to a change of phase. It is reversible, and a single crystal suffers no damage by being repeatedly heated to 100° C. and cooled to room temperature, a fact which also indicates that no recrystallization has occurred. Fig. 1 (left) is not identical with the Laue photograph reproduced in Morgan and Astbury's paper, presumably on account of different conditions of excitation of the X-ray tube. Our photographs were obtained with radiation from a silver target operated at 60 kV. Fluorazure intensifying screens were used; exposure 10 min. at 18 ma.; 5 cm. film to specimen. It will be noted that in Fig. 1 the intense reflections 612, 210, 520 are not accompanied by their counterparts 621, 201 and 502 on the opposite side of *AA'*: in general, the intensity of (*hkl*) is not equal to that of (*hlk*) below 30° C.

The cause of the change in symmetry of the Laue photographs is probably most easily seen by the aid of the diagram (Fig. 2*a*), which is a sketch (not to scale) of part of the molecule near the corner of the unit cube. The unique oxygen atom at *O* falls in

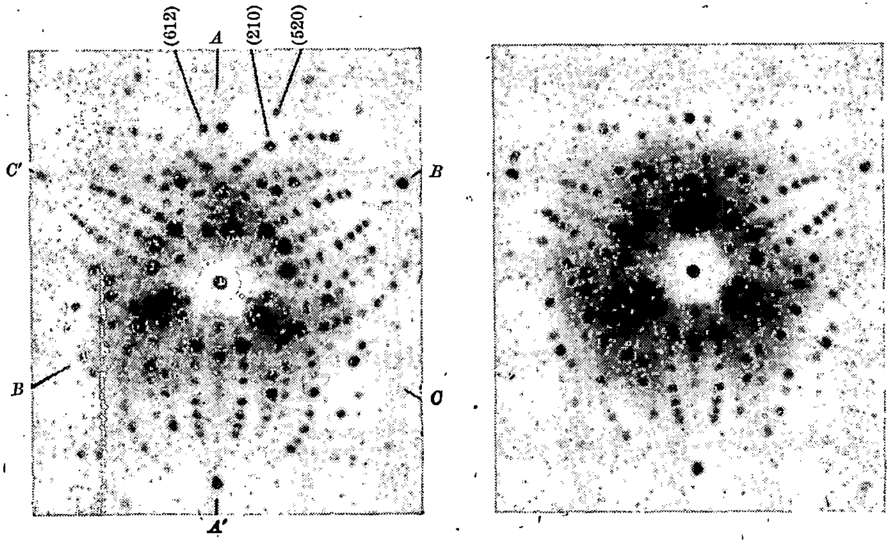
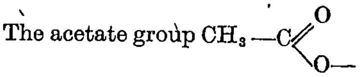


Fig. 1. Laue photographs of basic beryllium acetate. X-rays parallel to [111], [211] vertical. Silver target; Fluorazure intensifying; 5 cm. film to specimen. Reduced in the ratio 3:2. Left: at room temperature. Right: at 100° C.

the centre of the regular tetrahedron B_1, B_2, B_3, B_4 of beryllium atoms. The acetate group  $CH_3—C\begin{smallmatrix}\diagup O\\ \diagdown O—\end{smallmatrix}$ is a plane Y-shaped structure, a methyl group at its foot, a carbon atom at its middle and two structurally equivalent oxygen atoms at the extremities of the arms. These are shown in the sketch at C_1, C_2, a and b. In the 'end on' view of Fig. 2*b*, B_1B_2, B_3B_4 are the traces of the edges of the tetrahedron of beryllium atoms viewed along XO. These edges are parallel to 110 axes of the unit cube and lie in planes of symmetry for the holohedral crystal. The line ab joining the two oxygen atoms is, at room temperatures, inclined to the line B_1B_2 (and B_3B_4); as the temperature rises, its mean position must be such as to produce a symmetrical distribution about this line. This can occur in several ways; for example: (1) if the atomic vibrations carry ab to $a'b'$ (symmetry about B_3B_4 is secured automatically if it is present about B_1B_2), (2) if the acetate Y rotates about its stem so that ab in Fig. 2*b* describe a circle. The mean position of these two atoms must have a symmetrical aspect to produce the photograph of Fig. 1, and must therefore be in, or at right angles to, B_1B_2.

Further investigation might throw light on the amplitude of the thermal movements to which the observed change of symmetry is due: the onset of vibration across the symmetry plane should be accompanied by an abnormal rise of specific heat. Molecular rotation in nitrate crystals has been reported by Hendricks, Posnjak and Kracek[5] and is accompanied by a change of symmetry such as that here recorded. It seems that if Laue photographs are used to determine symmetry, they should be taken at as low a temperature as possible.

We are indebted to Dr. D. V. N. Hardy, Chemical Research Laboratory, for the preparation of the single crystals of basic beryllium acetate used in this investigation.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

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Jan. 11.

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Magnetization of Matter by Ultra-Violet Radiation

Ehrenhaft and Banet have reported[1] finding that nagnetic poles are produced in various pieces of 'non-magnetic" and annealed pieces of iron by exposure to ultra-violet radiation. The detecting instrunent used was a simple compass needle. Focken[2], on the other hand, repeated these experiments with nore sensitive apparatus, but found no evidence of any such induced magnetization. We have recently attempted similar experiments.

The deflexion magnetometer used was of the reflecting type and its sensitivity was 9,800 mm. at one metre per oersted, as compared with 9,000 mm. at one metre for the instrument used by Focken. We consider that for specimens distant 10 cm. from the needle, a change in the magnetic moment of 0·25 C.G.S. unit could be detected with certainty. The ultra-violet source was a D.C. mercury arc enclosed in a quartz envelope. The specimen under test was placed with its centre 10 cm. from the needle and in the end-on position with respect to it. In this position, one surface of the specimen was fully exposed to radiation propagated at right angles to its length. Each specimen was also exposed to radiation propagated, approximately parallel to its length, and to do this conveniently, each was moved to the broadside position. In these positions, the material was always placed at right angles to the magnetic meridian. With the arc running, and the specimen in place, but shielded from the radiation by a shutter, the magnetometer reading was noted. The shutter was then opened, the light spot from the magnetometer being kept under observation. This procedure ensures that the only change in conditions is exposure to radiation, other magnetizing influences such as the fields of the arc and the earth remaining substantially constant throughout any given test.

The experiments were also repeated for end-on and broadside positions when the radiation was concentrated on the specimen by means of a quartz lens.

Three types of materials in the form of rods, approximately 8 cm. long, were tried, namely, transformer iron, mild steel and a hard steel.

In no case could any change be detected in the magnetic condition of the rods, either at the instant of exposure or after exposures ranging from ½ hour to 3 hours. By placing the rods in a vertical position and illuminating as before, we tested for possible magnetization at right angles to the length. Here, also, the results were negative.

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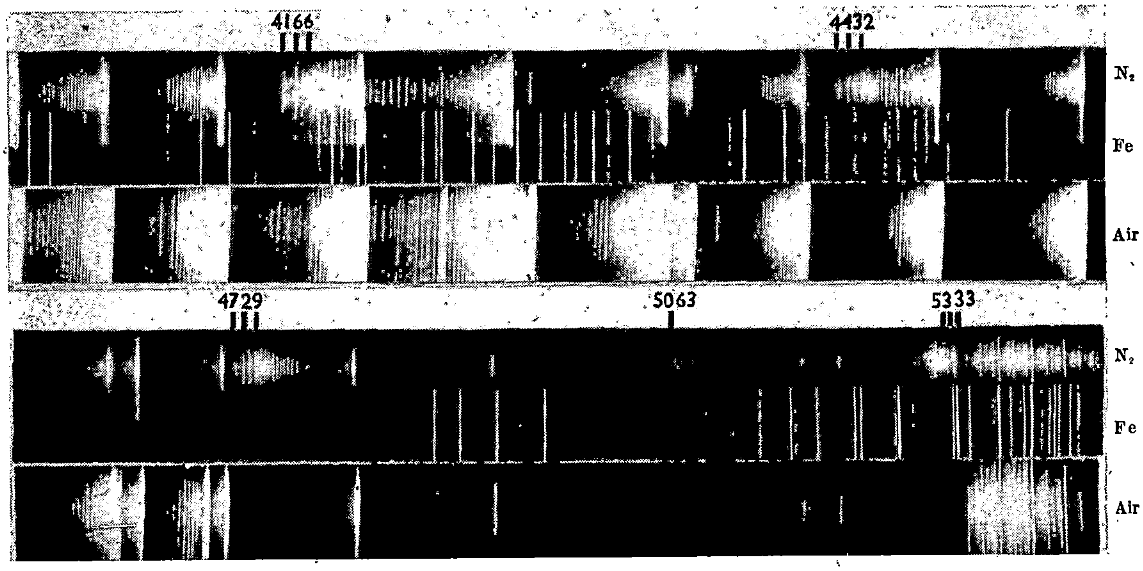
[1] Ehrenhaft, F., and Banet, L., NATURE, **147**, 297 (1941).
[2] Focken, C. M., NATURE, **148**, 438 (1941).

A New Band Spectrum Associated with Nitrogen

DURING an attempt to improve measurements on the Vegard-Kaplan bands of N_2 using a silent (ozonizer type) discharge through nitrogen as source, as recommended by Wulf and Melvin[1], three new bands in the blue region of the spectrum were observed. These bands were afterwards obtained quite readily in an ordinary induction-coil discharge through nitrogen at relatively very high pressure (around 10 cm. mercury). The bands were obtained with commercial nitrogen, with special oxygen-free nitrogen, and with atmospheric nitrogen made by bubbling air through alkaline pyrogallol. The bands do not appear at lower pressure or in discharges through air. The bands disappear if a little oxygen is mixed with the nitrogen, and hydrogen and water vapour also have an inhibiting action. In all the spectra taken, the NO γ and OH bands were weakly present, but all the experimental evidence seems to favour the assignment of the bands to N_2.

The accompanying illustration shows the bands as photographed on a glass prism spectrograph with a dispersion of around 10 A./mm. A spectrum of a discharge through air showing only the First and Second Positive bands of N_2, with a little N_2^+, is given for comparison. The new bands are degraded to the red and show several heads, having a complex rotational structure rather similar in general appearance to that of the Third Positive bands of carbon monoxide ($^3\Sigma \rightarrow {}^3\Pi$). Three of the heads of the three strong bands have been carefully measured and are given in the table, with *provisional* assignment of vibrational quantum numbers. The head of the 4,166 A. band falls on a strong grouping of lines (due to perturbations) in the (2,6) Second Positive band.



v', v''	λ	ν
0,0	4166·5	23994
	4171·6	23965
	4178·3	23927
0,1	4432·0	22557
	4438·2	22525
	4446·0	22486
0,2	4729·2	21139
	4736·0	21109
	4744·2	21072

Weaker bands at about 5,063 and 5,440 A. may be the (0,3) and (0,4) bands respectively, but overlapping by weak First and Second Positive bands of N_2 renders accurate location of heads difficult. There is also weak band structure around 5,575 A., which *might* be the (1,5) band.

The separation between the (0,0) and (0,1) and between the (0,1) and (0,2) bands is 1,440 and 1,416 cm.$^{-1}$ respectively. The corresponding differences for the $A^3\Sigma$ state of N_2 are 1,432·5 and 1,404·7. The present measurements should be accurate to 1 or 2 cm.$^{-1}$, and, unless there is a big difference between the positions of the origins and heads of the bands, it can be assumed that $A^3\Sigma$ is not involved.

It seems surprising, at first sight, that a readily observable system of N_2 in the blue should have been overlooked for so long, but it may be pointed out that the bands are overlaid by the much stronger Second Positive system, which were not themselves accurately measured before 1940[2]. The discovery of a new system of N_2 involving two new molecular states, probably of fairly low energy, gives some support for the view recently expressed by Gaydon and Penney[3] that the non-crossing rule, that potential curves of molecular states of the same species cannot cross, may hold for nitrogen, and thus that the dissociation energy is higher than the value of 7·38 electron volts in common use.

In addition to the new band system, a single band, degraded to the violet with heads at 5,333·5, 5,327·3 and 5,320·0 A., also appears in spectra of the ozonizer discharge and in a low current-density induction-coil discharge at high pressure through nitrogen. This may correspond to still another system of N_2, but the assignment is less certain.

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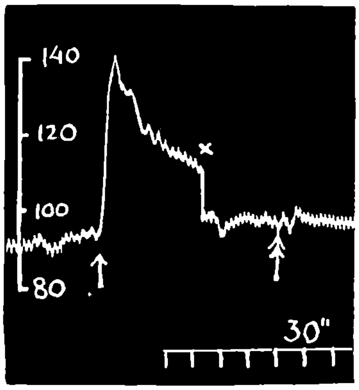
[1] *Phys. Rev.*, **55**, 687 (1939).
[2] Pankhurst, R. C., *Proc. Phys. Soc.*, **52**, 388 (1940).
[3] NATURE, **150**, 406 (1942).

Pressor Substances in Urine and Plasma from Normal and Hypertensive Subjects

NORMAL urine contains a pressor principle[1] which has been identified as *iso*-amylamine[2] and found t account for most of the urine pressor action.

If normal urine is concentrated *in vacuo* at neutra or slightly acid reaction and quantitatively extracte with ether at *p*H 9–10, the ethereal extract con sistently contains a pressor substance which conform in its properties with *iso*-amylamine. A strong presso action was generally obtained with an amount o extract corresponding to 100 ml. normal urine Similarly prepared extracts from the urine of te hypertensive patients (essential hypertension an chronic nephritis) contained much less of this sub stance when tested on the cat's blood pressure. Thu the extract of 100 ml. urine in some cases was com pletely inactive (see accompanying figure). It has been reported that the urine pressor activity does not differ significantly in extracts from normal and hypertensive subjects[3], but also that urine from arteriosclerotic and hypertensive patients contains less of the pressor substance, though no quantitative data have been given[1,2].

No evidence has been obtained in our experiments for the presence of significant amounts of other ether-soluble pressor agents, such as tyramine. This is in accord with other observations[4]. Ether extracts of acidified urine may contain small amounts of a pressor substance, differing from *iso*-amylamine.



CAT'S BLOOD PRESSURE. ↑ ETHER EXTRACT OF 100 ML. NORMAL URINE. ↑ ETHER EXTRACT OF 100 ML. URINE FROM PATIENT WITH ESSENTIAL HYPERTENSION.

Extracts of heparine venous plasma from normals and hypertensives were prepared by precipitation with alcohol and concentrated *in vacuo*, the residue being extracted with ten volumes of methyl alcohol, which was distilled off. When tested on the cat's blood pressure, normal plasma extracts regularly produced a moderate rise in pressure in amounts corresponding to 25 ml. plasma, whereas plasma extracts from hypertensive patients usually produced a much smaller action, in both cases preceded by a short lowering of the blood pressure. The test animals were atropinized and had received 0·15 mgm. ergotamine tartrate per kgm. in order to exclude the action of the buffer nerves.

The results suggest important changes in the production or excretion of biologically active metabolites in essential hypertension.

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Karolinska Institutet, T. SJÖSTRAND.
Stockholm. Jan. 10.

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Determination of the Osmotic Pressure of Biological Fluids

IN 1938 Blegen and Rehberg[1] described a method for determining the osmotic pressure of biological fluids based on the measurement of the initial rate of outflow of water from one solution through a semipermeable membrane into another solution of somewhat higher osmotic concentration. As semipermeable membranes they used small collodion bags impregnated with copper-ferrocyanide[2]. The collodion bag is alternately filled with the unknown fluid and with a solution of sodium chloride of known strength, and is connected to a piece of capillary tubing (0·2–0·5 mm. internal bore) which is bent at right angles so as to form a longer, horizontal arm of about 15 cm. length carrying a millimetre scale. When the bag containing the unknown fluid or the sodium chloride solution is immersed in a sodium chloride solution of higher concentration, the meniscus begins to move, and the rate of movement, which is taken to be proportional to the concentration difference, is determined at intervals.

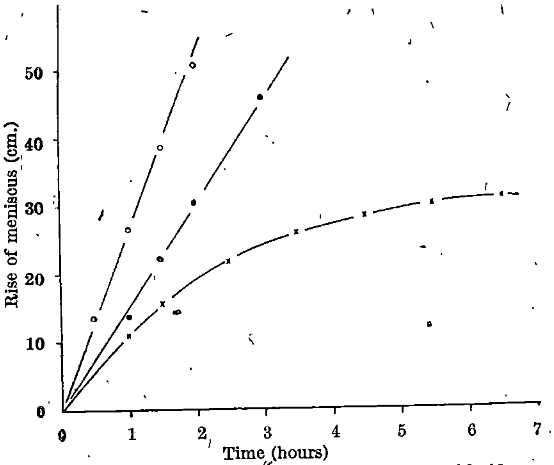
It was thought that this simple method might provide a suitable technique for detecting the presence of added water in milk. Unfortunately, on careful examination of the method I was unable to substantiate some of the claims made by Blegen and Rehberg for it, and this note is intended for the guidance of others who may be attracted by the apparent simplicity and ease of the procedure described by the Norwegian authors.

Batches of membranes were prepared by the method described by Blegen, and standardized by determining the rate of movement of the meniscus for 0·80 against 1·00 per cent sodium chloride solution. Only membranes which gave a constant rate of movement for at least 40 minutes were used in further work. A series of membranes was selected varying in the rate of movement from 1 mm. to 20 mm. per minute, using capillaries of 0·25 mm. internal bore. With all these membranes it was possible to determine the concentration of sodium chloride solutions with great accuracy, thus far confirming Blegen and Rehberg's findings. Difficulties arose, however, as soon as milk was chosen as the 'unknown' fluid. A rapid movement of the meniscus was observed, even when a bag filled with milk was immersed in salt solution isosmotic with the milk.

Blegen and Rehberg state that with serum the results of their method were "of the same order of magnitude as with Hill's (thermo-electric) method", but only one example in which actual comparison was made between the two methods is cited. The results were in good agreement, but the value of 0·179 n = 1·05 per cent NaCl is outside the usual range of values for human serum of 0·90–0·97 per cent NaCl[3]. In tests with sera prepared from cow's blood, I found that the results obtained by the Blegen and Rehberg method were always appreciably higher than those of the freezing point test which was used as method of comparison. Thus, a serum with a freezing point corresponding to 0·94 per cent sodium chloride gave a value of 1·02 per cent sodium chloride when tested by the water permeability method.

The difficulties encountered with milk and serum led to a study of simpler systems, using a modified experimental arrangement in which collodion bags were connected to vertical capillary tubes of about 60 cm. length and of approximately 1 mm. internal bore. Isosmotic solutions of sodium chloride, urea, and sucrose were tested against each other, and the accompanying graph shows results typical of these experiments.

An apparent 'osmotic pressure' between solutions which were, in fact, isosmotic was observed with all membranes, even with those which showed little movement of the meniscus in the standard test with sodium chloride solutions mentioned above. The anomalous behaviour finds its explanation in the fact that the membranes are not truly semipermeable,



All solutions isosmotic to 0·88 per cent sodium chloride.

	Inside membrane	Outside membrane
×	NaCl	Urea
●	Sucrose	NaCl
○	Sucrose	Urea

but allow the slow diffusion of small molecules and ions. The more diffusible substance will then increase the osmotic concentration on the opposite side of the membrane, thus causing a flow of water in that direction, with the result illustrated in the graph. As the osmotic forces in milk, serum and other biological fluids are due to a variety of substances in addition to sodium chloride, anomalies of the kind observed are only to be expected with these fluids. Unless a method can be designed by which truly semipermeable membranes can be prepared with ease —and in this I did not succeed—the technique of Blegen and Rehberg appears scarcely commendable for biological work.

In conclusion, brief mention should be made of the interesting possibility of the occurrence of membranes of the 'slowly-permeable' type in living organisms. The graph illustrates clearly the considerable forces at play between isosmotic systems separated by this type of membrane.

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Jan. 15.

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[1] Blegen, E., and Rehberg, P. B., *Scand. Arch. f. Physiol.*, 80, 40 (1938).

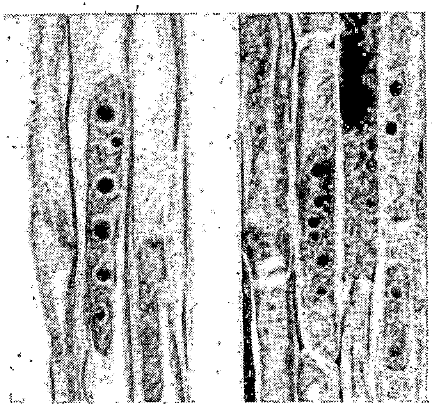
[2] Blegen, E., *Scand. Arch. f. Physiol.*, 81, 8 (1939).

[3] Margaria, R., *J. Physiol.*, 70, 417 (1930).

Nucleoli in *Agropyron repens*, Beauv.

DURING an investigation of the shoot apex of *Agropyron repens*, Beauv., longitudinal sections were obtained in which the nucleoli stood out in strong contrast to the rest of the nucleus. When this was noticed, counts were made and the maximum number per nucleus was found to be six. Photograph *A* shows the six nucleoli in the nucleus of a developing sclerenchyma cell, while *B* shows the six in the nucleus of a procambium initial. Sometimes there was a suggestion that the nucleoli were of three sizes, a large pair, a slightly smaller pair and a small pair, though this was not at all definite, and the appearance shown in *A* and *B* seemed more common (? some nucleoli only partly represented in the sections).

Observations were easiest on the cells of the developing strands and the associated sclerenchyma because the nuclei here are considerably elongated and there is consequently less tendency for the nucleoli to fuse together. Since these nuclei are about five to eight times as long as they are wide, it is often possible to have all six nucleoli well separated from each other and all in focus at the same time, making it fairly easy to observe and photograph them.


A B

NUCLEOLI IN *Agropyron repens*, BEAUV. (× *c.* 1000).

The possession of six nucleoli by *Agropyron repens* is interesting, first, because it accords with the hexaploid somatic chromosome number of 42 (Avdulov[1], Peto[2], although they also record plants with 28, 34 and 35 chromosomes), and secondly, because it is paralleled in the hexaploid wheats *Triticum vulgare* and *T. Spelta*[3], which have a somatic number of 42 and also possess six nucleoli.

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Synthetic Rubber

CLEARLY Dr. Naunton is acutely sensitive, justifiably, about synthetic rubber. His review of my book in NATURE of December 26, p. 751, is unfair in several respects. Undoubtedly, there are errors in the book. I am grateful to have them pointed out. But why add to them ?

Dr. Naunton says : "The author apparently is under the impression that isobutylene and butadiene will co-polymerize in almost any proportions in which the experimenter mixes them, but this is, of course not the case". On several pages I state that butyl rubber is a co-polymer of olefine with a small amount of diolefine.

He scorns my account of handling butyl rubber. Yet the latest official directive for handling butyl rubber states : "The following precautions will greatly enhance the ease of handling butyl rubber on the mill : (*a*) mill roll temperatures at the outset should be warm, 105 deg. F. to 115 deg. F. When the band has been formed, and during mixing, roll temperature should be kept as low as possible". Am I so far wrong ?

Dr. Naunton dismisses too lightly the part chemical concerns are playing in the United States productions. He is evidently a scientific 'Bourbon' in his underestimation of the intelligence of the 'general reader'

Three out of thirteen references on "Copolymerizaion" are to U.S.S.R. work; two to British work. As the subject is considered in relationship to synhetic rubbers, is this so unbalanced as to justify Dr. Naunton's querulousness ?

An official directive on Hycar OR, with Dr. Naunton's name attached, does not differ substantially from my own comments. I am somewhat mystified by the criticism.

I reiterate my belief that the industrial welfare of Great Britain can only be guaranteed by achievement based on hard work, and not merely by disussion and buying licences.

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HARRY BARRON.

I CANNOT agree that the review of Dr. Barron's book was unfair. It was critical but definitely not unfair.

It is true that Dr. Barron states in the book that he commercial product known as butyl rubber conains only a small amount of diolefine, but the riticism was levelled at the general case of interpolymerizing of isobutylene and diolefines, where mportant generalizations have been missed and miseading facts and figures have been quoted. Dr. Barron would be well advised to put more trust in xperimental work and less in published information. The *fact* remains that butyl rubber runs smoothly on cold mill but breaks up on a hot one.

I think Dr. Barron is confusing intelligence with nowledge. The 'general reader' is often far more ntelligent than the chemist, but no amount of ntelligence without chemical knowledge will enable im to appreciate structural formulæ.

I would remind Dr. Barron that I was not querulous" about the emphasis which had been iven to U.S.S.R. work on co-polymerization but on he narrower field of the constitution of co-polymers. The work of Hill, Lewis and Simonsen published in 939 should surely have been mentioned.

In Dr. Barron's comment about Hycar OR, we ee at last our different points of view. Dr. Barron wishes to paint a picture in which effect is obtained t the cost of only substantial accuracy, but a textbook as distinct from journalism is not a picture but sharp photographic reproduction of facts.

Manchester.

W. J. S. NAUNTON.

Future of University Education

THE British Association report on Post-War University Education (see NATURE, December 19, 1942) ontains some excellent suggestions. The plea for he further extension of residential facilities at the modern universities, for example, is fully justified by xperience in the University of Reading, which was pioneer in this field. Nor will anyone dissent from he Committee's premise that a scientific career hould be broadly based upon the "humanities". ne must, however, disagree with the conclusion hich is drawn that a study of the "humanities" hould be included as an essential part of the univerty 'honours courses' for science students. All eshmen will, before entering their honours course, ave enjoyed some six or seven years of secondary ducation, and it is in the secondary school that the ssential foundations of a general education should ave been laid. The period available is ample, if isely used, to stimulate any intellectual interests of hich the student is capable, and of laying a foundation upon which he should be able to develop those interests by leisure reading.

If, in point of fact, the schools have been betrayed (whether by the pressure of the university scholarship system, or other cause) into too great specialization, so that the present undergraduate is less widely read than his predecessors, the remedy is to be found by an overhaul of the school curriculum rather than by inserting irrelevant subjects into university courses. Omniscience is no longer a possible educational objective, and there must be some stage at which a science student begins to concentrate upon those special subjects, the mastery of which will enable him to make his specific contribution to the welfare of society. I suggest that this point comes naturally at the beginning of his university career. A wise tutor will, no doubt, encourage his students to a wide course of reading in their leisure time, and to a reasonable participation in undergraduate societies; but the student should not be distracted from his main objective by having to face an examination in any non-related subject.

There is one point, however, on which I believe the Committee has moved on to very dangerous ground. It is, perhaps naturally, expressed more clearly in the article in NATURE on the report than in the more cautious words of the Committee itself. I quote the relevant paragraph.

"It is therefore with a feeling of deep satisfaction that we note the Committee's insistence on training for world citizenship in all faculties, pass and honours, of our universities. . . . Social studies and the humanities must play a certain part in the training of all students. This applies especially to science students, for it is almost axiomatic that, in present circumstances, a man might gain a first-class degree in science and be no more appreciative of the essentials of world citizenship than any less fortunate individual who has not gone so far as through a secondary school."

To suggest that a graduate is, or ought to be, a higher type of *citizen* than the man whose gifts do not lead to a university education is to misunderstand the nature of citizenship in a democratic community. It has a totalitarian ring about it, and is calculated to arouse indignation in many manual workers who feel, and rightly so, that their conviction of what constitutes the basis of a sound social order is entitled to as much respect as that of the intellectual. I hear from colleagues who have recently been holding discussion groups with the Forces that similar pronouncements by our 'intelligentsia'—who are apt to take it for granted that high intellectual training is a pre-requisite for leadership in the new age—is already causing serious resentment.

Society will choose its own leaders; wisely, we may hope, but certainly for qualities in no way connected with academic distinction, even in sociological subjects. But society will also need, for its great task of restoration, men and women of high ability and intensive training in each of the sciences—and the humanities, too—and will welcome them, not as superior world citizens, but for the special contributions which their scientific education enables them to make. The education and training of these experts is the special function of the university, from which it should not be deflected. For the undergraduate who has the ability which justifies an honours course in science, the eager pursuit of the training which is to fit him for this task is his best form of social service.

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SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

THE annual conference of the Society of Agricultural Bacteriologists, held at the University of Leeds during August 27–29, 1942, reflected the influence of war-time conditions. Several members of the Society were unable to leave their duties in order to attend the conference, and the papers, particularly those concerned with dairying, showed that problems of immediate practical importance are being investigated. The field covered by the discussions was nevertheless wide and afforded an index of the activities of a society which exists with the object of advancing the study of general, agricultural and related branches of bacteriology.

A contribution to the bacteriology of sewage disposal dealt with the nitrifying activity of biological film from percolating filters. The activity was measured by inoculating an ammonium sulphate-calcium-carbonate solution with a dilute suspension of film, aerating the cultures in inverted conical flasks, and determining the rate of production of nitrite and nitrate. Nitrifying activity was found to be influenced by season, depth below the surface of the filter and the rate of treatment of sewage. Film produced in ordinary single filtration acted differently from film obtained in the process of alternating double filtration, in which two filters are operated in series, with a periodic change in the order of flow.

In the disposal of certain industrial wastes the activity of the sulphate-reducing organism *Vibrio desulphuricans* may require control. It has been shown that this microbe may be easily suppressed by the relatively simple and inexpensive method of adjusting the hydrogen ion concentration to less than pH5 or more than pH10. An illustration of the practical application of this principle was cited. A pond used for the reception of a waste containing 20–30 per cent of fatty matter and 3–4 per cent of sulphate (as calcium sulphate), at the rate of about forty tons a week, created a nuisance in the locality owing to the evolution of hydrogen sulphide. The pH value of the water was brought to 3 by adding sulphuric acid and the trouble was eliminated.

Shellfish which have been subjected to the process of self-purification in tanks of clean sea water have recently provided a problem. On arrival at inland markets they sporadically harbour large numbers of coliform organisms, and the suspicion that purification has been inadequate naturally arises. Investigation showed, however, that this occurrence is due to multiplication during transport of coliform bacilli which have no sanitary significance. With the object of finding a rapid method which would differentiate typical *Bacterium coli* from other members of the group, the modification of the Eijkman test using MacConkey's broth was re-investigated. Taking the production of acid and gas as the differential criterion, an incubation temperature of exactly 44° C. afforded the best separation of the types. In an examination of 1881 cultures derived from a variety of sources, 97·5 per cent of the typical *B. coli* produced acid and gas at 44° and only 5·2 per cent of the other coliform strains did so.

The coliform group in its relation to dairy products was also discussed. It has been found that the presumptive test for the presence of these organisms when applied to milk gives a lower estimate of the coliform population than when applied to water. Abnormal gas formation in factory-made Cheddar cheese was attributed to coliform bacilli introduced into pasteurized cheese milk from such sources as coolers and pipe lines. While various types of this group were isolated, typical *B. coli* predominated at all stages in the making and ripening of the cheese examined and appeared to be responsible for the majority of cases of gas production.

Bacteriophage active against streptococci, which may be responsible for difficulties in the making o Cheddar cheese, has now been successfully demonstrated in high dilutions prepared from cheese up to 3½ months old.

The resazurin reduction test is receiving much attention as a means of grading milk. One pape described the chemistry of resazurin and gave practical hints on the test. Other two papers dealt with the 10-minute resazurin test which is now used fo the rapid recognition of unsatisfactory milk, a product which has become an important problem unde war-time conditions. According to the colour of the milk-dye mixture after 10 minutes at 37° C. milk may be classified in three categories: (1) suitable fo the liquid milk market, (2) suitable for manufacture only, and (3) unacceptable for any purpose. The results usually agree with those of methylene blue reduction and are obtained in a shorter time. Othe rapid tests, such as those utilizing titratable acidity pH, clot formation on boiling, alcohol precipitation smell and taste, have been found to be less suitabl for use on the receiving platform of creameries. A fourth paper presented evidence that the resazurin test, when performed at 18° C., gives within two hour a reliable indication of the keeping quality of milk Samples of really poor keeping quality can be detected within 30 minutes by the 18° test.

Mastitis of the dairy cow was discussed in thre contributions. A comparison of diagnostic method applied to a large number of samples led to the conclusion that for the detection of sub-clinical mastiti a combination of two indirect tests, the determinatio of the leucocyte content and of the electrical conductivity of milk, is superior to the isolation an identification of the infecting organism in reliability speed and cost of materials. Milk from an infecte quarter has an abnormally high cell count and largely owing to an excess of chlorides, a high conductivity. The standards adopted to differentiat between normal and infected milk were 500,000 cel per ml. and a conductivity of 49·0 × 10^{-4} mhos.

In the second paper on mastitis, which describe field observations on the control of the disease methods of cultivating *Streptococcus agalactiæ* wer compared, and evidence was presented to show that factors such as unsuitable milking machines have a important influence in raising the infection rat The third paper dealing with mastitis described broth containing peptone, yeastrel, mannitol, æsculi and hippurate which permits *S. agalactiæ* to displa the majority of its differential characters. It is thu possible to identify the organism by preparing single culture in the composite medium.

Other contributions to the proceedings dealt wi methods of increasing the heat resistance of th spores of a putrefactive anærobe and with the contr of moulds (Penicillium and Mucor) in meat pies b changing the methods of manufacture.

In spite of difficulties due to the War, this conferen was most successful and did not depart from th trend towards greater variety of interests which ha characterized annual meetings of the Society.

BIRDS AND BUTTERFLIES

By Dr. C. B. WILLIAMS

Rothamsted Experimental Station

THE extraordinary mimetic resemblances which exist between certain apparently edible species of insects and other distasteful species, which are found in the same neighbourhood, reach their highest development in the Rhopalocera or butterflies. The resemblances are purely external and frequently confined to the upper surfaces of the wings only. They are obviously meant to deceive an eye.

If this mimicry has been brought about by natural selection of smaller or larger variations because they are of survival value to the mimics, there must be some enemy whose eye is deceived, and further, in view of the perfection of many of the resemblances, it must be sometimes not deceived by the less perfect resemblances.

Undoubtedly the chief death-rate of butterflies is n the egg, caterpillar and chrysalis stage, but these resemblances which we are now considering are in the adults, so that we have to search for an enemy which can exert a considerable selection pressure in the short period between the emergence of the butterly from the chrysalis and the time that most of ts eggs are laid; for after this latter no selection is of survival value to the race.

We need, therefore, a sharp-eyed predator which s active by day and which sees the butterflies when their upper surfaces are exposed, that is, probably when in flight. Birds are the obvious choice, but when the suggestion was first critically examined it was found that the evidence of bird attack on butterlies was very small. Quite experienced field naturalists commented on its rarity.

In the subsequent search for evidence two promising ines of work have been in progress. At an early stage field experiments were made by offering to tame or wild birds butterflies that were believed to be palatable or distasteful, together with mimics of the atter.

More recently, progress has been made by the discovery that the butterfly wings often show definite marks where they have been nipped by the beak of a bird. In these cases, of course, the butterflies have been fortunate enough to escape. The marks may be so definite that the size and angle of the beak may be measured and a close guess made at the group or even species of bird that caused the injury.

Prof. G. D. H. Carpenter has been associated with these lines of study for many years and in two recent papers*, one prepared from notes left by the late C. F. M. Swynnerton, he brings forward much new evidence on both counts.

On the problem of the relative frequency of beak marks he shows that in more than ten thousand museum specimens of the distasteful genus Euploea, 123 (1·15 per cent) showed beak marks on the wings; n more than six thousand African Danain butterflies, also distasteful, 117 (1·05 per cent) had marks; but in more than seven thousand African Colotes spp., a quite edible genus, only 11 (0·15 per cent) were marked.

The inference is, as Prof. Carpenter points out, not that the distasteful species are more frequently bitten by birds, but that, being bitten, they more frequently escape or are allowed to escape.

A comparison was also made between 550 distasteful Danaine models which showed 17 individuals with beak marks, and 340 Nymphaline mimics, of which there was only a single one with a beak mark.

In an appendix to this paper, it is also shown that of 613 distasteful butterflies from all parts of the world which had beak marks, 133 or 21 per cent had evidence of more than one attack, while of 179 edible butterflies with beak marks only 21, or 11·7 per cent, had evidence of more than one attack. The difference is statistically significant.

Prof. Carpenter's conclusion, which seems to be justified, is that distasteful (aposematic) species are more frequently found with beak marks because they "live to fight another day", owing to not having been eaten by their bird enemies even when they have been seized.

The summary of Swynnerton's field experiments is a mine of interesting information. The main portion deals with the behaviour of birds towards butterflies of different species which were 'planted' in positions visible to the birds but prevented by various means from flying away. Twenty-two such experiments are described and the results are very striking. Time and time again the more distasteful species are either completely neglected, or, even more convincingly, carefully examined at first and then neglected. The more palatable species, on the contrary, were eaten in very high proportions. The distinction between palatable and distasteful is not absolute but comparative, and very hungry birds will eat relatively distasteful species, while replete birds will require to be tempted by a particularly choice morsel. Other things being equal, a hungry bird will eat a large butterfly in preference to a smaller one.

In one example given (Section C, Experiment 1), 84 butterflies were exposed, and after five hours 45 had been eaten. Among the butterflies were 7 Danains (aposematic), none of which had been touched, and 24 *Vanessa cardui*, of which 22 had been eaten.

In other experiments the birds were shown to be definitely deceived by mimics of aposematic species.

There is no doubt that a considerable body of evidence has been brought forward to show that birds are important and critical enemies of butterflies, that they have to learn by experience the appearance of distasteful species, and that once having learnt this they are frequently deceived by mimetic resemblance.

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* (1) Observations and experiments in Africa by the late C. F. M. wynnerton on wild birds eating butterflies and the preferences shown. *Proc. Linn. Soc. Lon.*, Session 154, 10–46 (1942).

(2) The relative frequency of beak marks on butterflies of ifferent edibility to birds. *Proc. Zool. Soc. Lon.* (A), 111, 223–230 1941).

UTILIZATION OF GLASS

PROF. W. E. S. TURNER read a paper on "New Uses for Glass" before the Royal Society of Arts on January 20. He briefly traced through history the development of the use of glass from its main original use for decorative purposes to its ever-widening use as an essential material for utilitarian purposes. No period has seen more fruitful advances than the past fifteen years.

Systematic scientific investigation has resulted in providing us with glasses having a density from 2 up to 8: a coefficient of thermal expansion varying at least thirty-fold; a range of thermal endurance such that objects made from some glasses can be heated to glowing and quenched in water without fracture; a range of load-bearing capacity up to six and even ten-fold; electrical resistance varying up to at least ten thousand-fold; while the non-corrodible character of modern types of glasses is such that it can and has replaced stainless steel, offers resistance to steam at high temperatures and pressure, to strong acids and many liquids which are chemically corrosive of other known materials and is without any action on the most sensitive of physiological, biological and chemical preparations.

Sheet glass is now drawn continuously in the flat state more than one hundred inches wide; plate glass is, by the latest British process, not only rolled continuously some 12 ft. wide, but is simultaneously ground and polished on both sides. Thousands of different articles such as bottles, jars, tumblers and drinking vessels of all kinds, even complicated articles like jugs with handles and wine glasses with feet, are now produced entirely by automatic machinery; half a million electric light bulbs per day are turned out by automatic machines and miles of glass tubing of various kinds and diameters. Glass can be converted into flakes and drawn into threads as fine as silk at the speed of some six thousand feet per minute, with numerous uses in the production of yarn and woven textiles, as filtering mediums and for insulating purposes.

The modern processes of tempering glass have tremendously increased its safety factor against breakage and made its use possible against extremes of heat and cold, for transparent pressure chambers, for high-power electric insulators, a base on which to spray a metal for grids to form electric radiators, for the tops of hot stoves, and for general constructional purposes, including doors provided with metal fittings. The combination of layers of glass with very thin layers of transparent plastic materials has given laminated glass for transport vehicles and, when used in multi-layers, bullet-resisting glass, as used in tanks and aeroplanes.

The advances in sealing glass to metals have made possible the construction of metal filament electric lamps, cathode ray tubes and radio valves; mercury arc rectifiers, in glass envelopes and operating with electrodes at high temperatures, are now in operation in many transformer stations.

Glass can also be coloured for the transmission of light and radiation; colourless glasses will transmit X-rays with high efficiency, whereas lead- and barium-containing glass provides screens for protection against X-rays. Glasses are made with a high transmission for ultra-violet light; and deeply coloured glasses can be made which transmit nothing but ultra-violet light on one hand or infra-red on the other.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, February 6

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Nutrition in Pregnancy".

British Rheologists' Club (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.15 p.m.—Dr. R. N. Haward: "The Extension and Impact Resistance of some Plastic Materials".

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. F. A. Bannister: "The Determination of Minerals by X-Ray Methods".

Monday, February 8

Institution of Chemical Engineers (joint meeting with the Chemical Engineering Group, the Yorkshire Section of the Society of Chemical Industry, and the Leeds Area Section o the Institute of Chemistry) (in the Chemistry Lecture Theatre The University, Woodhouse Lane, Leeds), at 6 p.m.—Dr. A. H. Jay "The Application of Crystal Analysis to some Chemical Engineerin Materials".

Tuesday, February 9

Royal College of Physicians (at Pall Mall East, London, S.W.1) at 2.15 p.m.—Prof. M. Greenwood, F.R.S.: "Medical Statistician from Petty to Farr" (Fitzpatrick Lectures, 1).

Royal Institution (at 21 Albemarle Street, London, W.1), a 3 p.m.—Sir Lawrence Bragg, F.R.S.: "The Solid State", (iii) "Minus minus Compounds".*

Illuminating Engineering Society (at Gas Industry House, Grosvenor Place, London, S.W.1), at 5 p.m.—Contributions on "Th Effectiveness of Lighting, its Numerical Assessment", to be followe by a Discussion.

Wednesday, February 10

Royal Society of Arts (at John Adam Street, Adelphi, London W.C.2), at 1.45 p.m.—Mr. R. G. Glenday: "Location of Industry".

Royal College of Physicians (at Pall Mall East, London, S.W.1) at 2.15 p.m.—Prof. M. Greenwood, F.R.S.: "Medical Statistician from Petty to Farr" (Fitzpatrick Lectures, 2).

Institution of Electrical Engineers (Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m —Discussion on "The Use of Electricity in relation to Fuel Economy' (to be opened by Mr. R. H. Rawll).

Friday, February 12

Royal Institution (at 21 Albemarle Street, London, W.1), a 5 p.m.—Dr. G. M. B. Dobson, F.R.S., and Dr. A. R. Meetham "The Air we breathe in Town and Country".

Saturday, February 13

Iron and Steel Institute (joint meeting with the Sheffiel Metallurgical Association, the Sheffield Society of Engineer and Metallurgists, and the South Yorkshire Section of th Institute of Chemistry) (at the Royal Victoria Station Hote Sheffield), at 2.30 p.m.—Mr. H. T. Shirley and Mr. E. Elliott: " Critical Consideration of some Applications of the Spectrograph t Steelworks Analysis".

APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Lecturer in Mining—The Principal and Clerk to the Governin Body, Wigan and District Mining and Technical College, Wiga (February 13).

Lecturer in Chemistry—The Principal and Clerk to the Governin Body, Wigan and District Mining and Technical College, Wiga (February 13).

Graduate Master or Mistress to teach Mathematics an Geography in the Harrogate Technical Institute—Mr. W. E. Jalland, The Secretary to the Managers, Municipal Offices, Harrogat (February 15).

Chair of Mining—The Secretary, The University, Edmund Stree Birmingham 3 (March 1).

Instructor in Beekeeping—The Education Officer, County Hal Wakefield (March 1).

Sir Dorab Tata Reader in Pharmaceutical Chemistry in t Department of Chemical Technology—The Registrar, University Bombay, Bombay, India (April 15).

Head of the Mining Department—The Principal, Coun Technical College, Mansfield, Notts.

Lecturer in Electrical Engineering—The Clerk to t Governors, South-West Essex Technical College and School of A Forest Road, Walthamstow, London, E.17.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Fuel and Power. Twentieth Annual Report of t Safety in Mines Research Board, 1941. Pp. 28. (London: H. Stationery Office.) 1*s*. net. [1

Other Countries

Bulletin of the American Museum of Natural History. Vol. Art. 6: The Fauna of Papago Springs Cave, Arizona, and a Study Stockocerus; with Three New Antilocaprines from Nebraska a Arizona. By Morris F. Skinner. Pp. 143–220. (New York: Americ Museum of Natural History.) [

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POST-WAR CIVIL AVIATION IN GREAT BRITAIN

THE debate in the House of Commons upon the policy of the Government towards the future of civil aviation, which took place on December 17, made public facts that are disturbing. They should be given much more attention than the complacency of the Air Ministry representative's reply suggests that they will receive. Indeed, the relatively small amount of comment which has been published shows that the matter is in danger of being put aside as of little importance except in connexion with plans for reconstruction, a topic which is still unfortunately regarded by many as too speculative to be of immediate importance.

There was a certain lack of perspective in the debate in that an unduly large proportion of the time was taken up in the airing of minor matters concerning the internal management of British Overseas Airways, the company that now exercises a monopoly control over civil aviation under British jurisdiction. Such matters as disciplinary troubles with the staff, and the fact that the Prime Minister's recent flights have been made in charge of pilots not of British nationality were discussed at considerable length. The Joint Under-Secretary of State, Captain Harold Balfour, in his reply, made it quite clear that the Air Ministry does not feel disposed to interfere in such cases, maintaining that, in effect, although these several mismanagements are admitted, they are not sufficiently serious to call for such a drastic step as the removal of the company's Board or even an individual member of it, which is the only real power that the country has in return for paying a subsidy of several million pounds a year.

The much wider and more far-reaching question which arose was that of the Government's attitude towards the present-day development of civil aviation, from the point of view of the situation that will arise in the immediate post-war period. An inter-departmental committee issued an interim report about eleven months ago, in the form of a series of policy questions to the Cabinet. Nothing further appears to have been done since, as until these questions of policy are settled, the committee obviously cannot continue to function on its details.

Meanwhile the gradual absorption of the world's air routes by the American companies is proceeding, sometimes by arrangement with Great Britain, more often because they are the only competitors in the field, but always because we, through lack of an organization and equipment, are not in a position to cater for the demand where it exists.

American air lines have a monopoly in the Pacific and the South Atlantic ; in the North Atlantic they are two to one (our one is run by a British air line but with American machines), in Africa civil air transport is being operated by Americans, and it is reported there will shortly be American air lines operating from Aden and India. This position of inferiority is due partly to the initial lead of the United States in matters of air transport in pre-war days, but it is aggravated by the war-time arrangement that British policy has been to concentrate on the design and production of the smaller aircraft, leaving the larger ones to the United States. This is logical from the delivery point of view, as the large long-range machine can be sent over to the various war centres under its own power, while the small fighter or medium bomber would absorb shipping space and be under greater risk of loss by submarine attack. It is unfortunate, however, in that the large machine is the type that is required for civil air transport, and thus the United States is able to divert a proportion of her output to civil purposes as required, and is gaining experience, and already using it, to design and produce newer and larger transport machines.

Nor does the discrepancy end with this. An air transport concern having a constant supply of newly designed machines and engines must not only be functioning with the utmost efficiency, but also be able to train the personnel in the use of these, and thus build up an organization of skilled staff. British Overseas Airways has no such advantages. Nearly half its equipment is earlier American, the rest being partly obsolete British civil transport machines, or the more modern of them are R.A.F. rejected types, designed for war purposes and converted so far as practicable to civil transport needs. Several of these are fitted with American engines. Actually there are seventeen types of aircraft with fourteen types of engines. The inefficiency, from the point of view of cost and man-hours involved in maintaining such a collection, must be staggering. Also no experience in the use of the more modern machines is being gained, a loss both from their own operational point of view, and that it will not be available to designers of civil aircraft and engines for the post-war period. This is the present position and, so far as is known, the Ministry of Aircraft Production has no plans in hand, nor has it placed any orders for either aircraft or engines specifically designed for civil air transport.

A concrete suggestion for the immediate improvement of this state of affairs, based on partial and rumoured promises, was put forward by Mr. Perkins in the course of the debate. It was that twenty "York" aircraft (a large bomber with a body re-designed for air transport purposes) or else a similar number of another machine outcast by the R.A.F., which he called the "W", together with ten "Sunderland" flying boats, be handed over at once to British Overseas Airways and also the American "Lodestars" now in our possession under the Lend-Lease Act. These should be fitted with the best of the modern developments in variable-pitch airscrews in order to promote safety and maximum efficiency in operation. Financially it would probably be an economy, as it would allow of the scrapping of an equivalent accommodation in old and obsolete aircraft which must now be operating inefficiently, and the reduction in the number of types would economize on maintenance costs. It would give the staffs experience in handling more up-to-date equipment, would help to bridge over the period when inevitably no new civil aircraft will be forthcoming, and would enable us, when the necessity arises, to approach the problem of coming to an arrangement with the United States on more equable terms.

For the future, the long-term policy advocated was to take civil aviation away from the Air Ministry, the principal interest of which, quite rightly, is to develop and maintain the standard of the R.A.F. equipment. A committee should be set up to survey the whole question of civil aviation—not only air transport—with instructions to report quickly, say in three months time. The present monopoly given to one concern only should be abolished, and a healthy sense of competition allowed to function. This could be controlled, giving certain fields to specialist firms to avoid overlapping, without giving complete monopoly to any one. The Government should at once initiate the commencement of the design of three aircraft and three engines definitely suited to three broad types of civil air transport work.

In this respect it is interesting to note the report of the American Maritime Commission, published nearly five years ago. Although not a body primarily interested in aviation, the Committee expressed the opinion that large aircraft are already capable of superseding luxury liners of the *Queen Mary* type. It envisaged a large flying boat, to-day a technical possibility, six of which could carry per year more passengers on the Atlantic crossing than did the *Queen Mary*, and moreover the trip would take ten hours or less instead of five days. The standard of comfort need be no less than we expect upon a night 'sleeper' on the London-Scotland railways.

From the political aspect, the possession of a large air transport organization would be of the greatest help. Rapid travel would expedite that personal contact between the really big executives that will be needed when the question of rearranging the democratic government of the world has to be faced. Many speakers during the debate hoped for the possibility of the establishment of the freedom of the air when that time comes. This 'open sky' policy should follow the lines of the accepted freedom of the seas. Free and unrestricted flight to all points should be given. No small nations should be allowed to obstruct by prohibiting flights over their territory. Unrestricted use of airports, these maintained with an agreed standard of equipment, lighting for night flying, and other such safety devices, must be provided by all nations. At the end of this War, with the Great Powers in a position to dictate, in a benevolent way, to the smaller States, the psychological moment for such an innovation would seem to have arrived.

The reply of Capt. Balfour, on behalf of the Government, was far from reassuring. Apart from answers to the several minor criticisms that were outside the question of broad policy, his speech was mainly a defence of having put the whole of our effort into R.A.F. equipment, concentrating on "first things first", and consequently our inability to get "more than a pint out of a pint pot". He welcomed the taking over of the British African air route by Pan-American Airways, disguised as part of the U.S. Army Air Transport Command, on the grounds that it is helping in our combined war effort. Exactly what the situation will be when the War ends, if the proposed freedom of the air is adopted, he did not mention. Pan-American Airways will have a complete monopoly of this, and possibly other Middle Eastern air routes, with machines, equipment, and personnel suited to the conditions as discovered by their experience. Apart from sentiment, Great Britain cannot show any claim to replace them. Without an alteration in our present policy, we shall certainly not be able to offer to the localities a better or even so good a service, lacking, as we shall, both experience and specially developed equipment.

The crux of the whole matter of policy appears to be that of the proportion of the aeronautical effort in Great Britain which is allowed to be devoted to civil aviation, particularly that part of it which is directed towards the long-range view of post-war requirements. The British allocation during 1942 was £5,000,000 given to one monopoly company, and a promise of a very small number of converted bombers and flying boats, none of which was conceived or designed as a commercial air transport machine, in the problematic future. Incidentally, £5,000,000, which Capt. Balfour described as "not such dusty crumbs", is the equivalent of about one day's expenditure upon war machines "at the rich man's table". Compared with this, the U.S. Aeronautical Chamber of Commerce stated recently that at present one fifth of the multi-engined production of aeroplanes in that country is devoted to cargo aircraft and that it is expected to rise to one third in 1943. In Great Britain we have British Overseas Airways as the only operating company. In the United States there are seventeen air lines operating under the direction of the Government authorities, but retaining their own individualities and spheres of influence. We have not one firm producing or even designing civil transport machines, whereas in the United States three of the largest concerns are producing cargo-carrying planes, while a fourth is just going into production on the world's largest passenger-carrying aeroplane, an 80,000 lb. monoplane, the "Constellation".

Any country's work in connexion with a total war must obviously be a balance between the production of direct war requirements and the many subsidiaries necessary to maintain national life. Aeronautics, as one branch of this, must be governed by similar laws. We may not be able to get more than a pint out of Capt. Balfour's pint pot, but the dregs allotted to civil aviation from the British pint would appear to compare very unfavourably with the gill that American aviation is getting from their pot. It is obvious that there are many facets to a political situation of this kind, and that it needs extremely delicate handling, but to the ordinary man it must appear that, in the world of aeronautics, Great Britain has either blundered or allowed itself to be jockeyed, which is really the same thing, into a position of bearing a little more than a fair share of the burden.

HYDRO-ELECTRIC DEVELOPMENTS AND RECONSTRUCTION

THE report of the Cooper Committee on "Hydro-electric Development in Scotland" (see p. 187), the main recommendations of which have now been accepted by the Government and embodied in the Hydro-Electric Development (Scotland) Bill presented to Parliament, is a reconstruction paper which will require the early attention of whatever planning authority may be entrusted with the responsibilities recommended by the Barlow Commission or the Scott Committee. The report formulates a programme or policy without attempting to work out its practical implications to the last detail, but in doing so it promotes an admirable appreciation of the position of hydro-electric development in Scotland and supplement to the report on the Highlands and islands of Scotland issued by the Scottish Economic Committee in 1938.

The broad conclusion which emerges from the survey of existing electrical development is that the northern area of Scotland differs fundamentally from all the electricity areas of Great Britain and calls for an exceptional development policy, practice and outlook. In that area there is abundant water-power but no coal; there are no substantial industrial concentrations, and the population is very sparse and widely dispersed. Water-power as a source of energy has different economic and financial characteristics from those of coal-fired steam stations. That portion of the area popularly designated the Highlands has for long been a depressed area and will remain so unless vigorous and far-sighted remedial action is taken in hand without delay.

The Committee considers in some detail the two main theories of the future of the Northern Area, on which most of the proposals laid before it were based. One view, that any attempt to introduce modern industries and industrial methods is foredoomed to failure, since the Highlander cannot and should not be separated from his croft or his boat, however meagre the existence they are capable of yielding, is emphatically rejected. The other view, that the real test of the validity of any electrical project is the promise it holds of attracting new industries, proceeds upon the sound and only possible principle of treating the Northern Area as a whole, developing the more advanced districts as fully as possible, establishing new centres of development at selected sites throughout the area, and trusting to the gradual diffusion of prosperity from these focuses of development into the surrounding districts, including the crofting areas.

In regard to this view it should be remembered, as the Committee comments, that the provision of cheap and abundant electricity is only one, though a very important, factor in any programme directed towards the expansion of existing centres of industry and the creation of new ones. Secondly, the types of industry to which under the Committee's proposals the Northern Area could offer a very special inducement are those such as the electro-chemical and electro-metallurgical industries, which employ very large quantities of electricity and for which the abundant supply of very cheap electricity is indispensable. In regard to these industries, the Committee states that it is inconceivable that a country such as Great Britain, which is so deeply interested in every aspect of the metal industries, could refrain from active and intensive participation in their remarkable development in recent years, especially in view of the increasing importance which in modern technique is attached to the use of alloys. Moreover, it is considered beyond controversy that there is only one possible zone for siting such industries in Great Britain, and that is in northern Scotland in the vicinity of the larger hydro-electric sources. In particular, the district adjoining the Cromarty and Beauly Firths, the Lochalsh area, the upper reaches of Loch Tyne and the upper reaches of Loch Linnhe are specified. If the post-war industrial economy of Great Britain is based on deliberate planning on the lines adumbrated in the Barlow Report, the Committee considers there is an unanswerable case for delimiting this area for the purpose of such industries.

The Committee is confident as to the possibility of offering these industries such advantages in power supply as will provide a powerful incentive to their establishment in the Highlands. It attaches importance to the uncovenanted benefits which may be expected to result from the introduction into this area of a new spirit of enterprise and initiative and the provision at strategic points of modern centres of the most modern industry, on the basis of which the local population can erect a better and richer economic structure the advantages of which should permeate every branch of the life of the people. It sees no reason why these new centres should not be planned as a model of what an urban centre in a rural district ought to be, and it anticipates nothing but benefits to the district as a whole from the establishment of such industries as new markets for the produce of the adjoining districts, from the incidental provision of improved transport facilities and from the numerous conveniences and amenities which must inevitably follow.

Whether or not this confidence proves to be justified will largely depend on the machinery by which the programme proposed is executed. Fundamentally, some of the most important opposition due to earlier proposals such as the Glen Affric project derived from the well-founded belief that no private corporation could safely be entrusted with powers which might affect so powerfully the amenities and the development of a whole kingdom. This important objection is eliminated by the Cooper Committee's first proposal, to create a new public service corporation, the North Scotland Hydro-Electric Board, to which would be entrusted the responsibility for initiating and undertaking the development of all further generation of electricity in the Northern Area for public supply, and its transmission and supply in bulk to the existing undertakings, as well as of the generation, transmission and distribution in all areas outside the limits of existing undertakers.

This Board should have three primary objectives in its development programme: to attract to the Highlands through the offer of cheap and abundant power a share in the vital and expanding electro-chemical and electro-metallurgical industries; to develop such further power as may be required for the consumers of existing undertakers or for consumers in its own distribution area, the surplus being exported to the grid; and to develop on an experimental and demonstrational basis isolated schemes in isolated districts.

The recommendations of this report are closely linked with the measures recommended by the Barlow Commission and the Scott and Uthwatt Committees. Not merely the reconstruction of a depressed area and the development of important new industries are involved. These problems are interlocked with those of the utilization of land as well as of natural resources—forestry, agriculture, the preservation of natural flora and fauna as well as of our scenic heritage, the provision of opportunities for amenities and recreation for the whole nation, questions of town planning as well as of country planning—all require consideration in the development and execution of a plan which will worthily meet the opportunities.

The Cooper Committee makes plain its opinion that it is opposed to any system under which a person whose property or interests may be affected by the execution of a large public utility scheme is entitled not only to claim compensation for loss he may suffer but also to oppose the entire scheme on its merits. Its proposals for compulsory powers and more business-like and modern machinery in this matter of acquisition and compensation, and for the exemption of new schemes from rates either permanently or for a prolonged development period, however, have not been incorporated in the Bill now before Parliament. The suggested provision for the appointment of an Amenity Committee selected by the Secretary of State to advise the new Board in framing and executing proposals is unlikely to be satisfactory, however favourable the precedents cited, unless the proposals of the Scott Report are also implemented. The issues raised by the Cooper Report are wide and general as well as specific, and afford an outstanding opportunity for bold enterprise on the part of the Government.

MECHANISM OF THE ELECTRIC SPARK

The Mechanism of the Electric Spark
By Prof. Leonard B. Loeb and John M. Meek. Pp. xiii+188. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1941.) 3.50 dollars.

ALTHOUGH this interesting book bears the copyright date of 1941 at the Stanford Press, it has only recently been available in Great Britain, and will be regarded as an important supplement to Prof. Loeb's treatise "Fundamental Processes of Electrical Discharges in Gases" (1939). The reason for the appearance of a supplement to a very modern book of such comprehensiveness is to be found in the discovery by an Englishman, one of the authors, J. M. Meek, of a simple condition or criterion, which, applied to Prof. Loeb's qualitative streamer theory of spark discharge, converted an interesting speculation into a quantitative theory of great power. Dr. Meek (formerly of the University of Liverpool and the Research Department of the Metropolitan-Vickers Company) studied under Prof. Loeb with a Commonwealth Fund Fellowship, and there developed the conception and mathematical argument which has led to the satisfactory explanation and correlation of many inexplicable, apparently unrelated phenomena of the spark discharge.

Meek's work has appeared in several scientific journals, but Prof. Loeb has rendered very useful service in reviewing the former streamer theory afresh in the light of Meek's discovery, and the book will constitute a valuable addition to one's library of "J.J." and other works on gaseous discharges.

The book is dedicated to Townsend, "whose pioneer researches and theory laid the whole foundation for the study of the mechanism of the spark discharge": one wonders whether Prof. Loeb was hoping thereby to bring Saul also among the Prophets, for on p. 374 of the longer treatise he wrote: "Unfortunately Townsend and his school have been the last to concede the errors in reasoning". It must be admitted, however, in fairness to Townsend, that although the second Townsend coefficient β may have been an over-simplified explanation of the true facts, the facts have been so elusive to modern research that hundreds of papers have been written on the subject, and finality is not yet in sight.

The development of new theories of the spark discharge has its origin in three new experimental techniques: first and most important, in the development by Rogowski in Aachen of the high-voltage cathode-ray oscillograph, with which time-ags of spark formation could be measured; secondly, n the application of the Wilson cloud chamber to the study of sparks in the early stage of their formation; and thirdly, in the successful application by Schonland of the rotating camera to the study of the ightning discharge. The book gives full consideration to the first two, but in the writer's opinion does not do justice to the third. After all, we owe to Schonland and his co-workers, so long ago as 1933, the first direct evidence that a discharge occurs in at least wo main stages, the electron avalanche or leader troke of varying degree of complexity, followed by he main stroke developing in the opposite direction o the leader stroke. This dual process (expanded to a triple process by the authors) is the basic idea underlying modern theory.

The book is written in three chapters. The first deals with the Townsend theory and the difficulties evealed by research over the past ten years; the econd deals with the mechanism of the positive treamer, including the application of Meek's riterion; and the third gives quantitative examples f Meek's formula applied to breakdown in a uniform ield, in the field of a sphere gap and of coaxial ylinders, and the way breakdown is influenced by xternal ionization.

Chapter 1 is a condensation of Chapter 10 of Loeb's longer treatise. The Townsend second coefficient β was originally the number of new electrons created in a gas by a single positive ion in unit distance. At N.T.P. the velocity of such an ion in the breakdown field is $\cdot 10^5$ cm./sec., whereas the oscillograph shows breakdown to occur in 10^{-7} sec. for a 1 cm. gap, apart from any statistical time-lag. Thus positive ion ionization is ruled out in accounting for breakdown at such values of pressure and gap; moreover, abundant evidence exists that the positive ions cannot reach ionizing energy in the available field. Nor can any action at the cathode be invoked, especially for long gaps; the secondary processes must all occur in the gas and not at the electrodes. Here the cloud chamber and the Kerr electro-optical shutter camera provided the vital evidence; the initial phases of spark breakdown occur at the anode, anode streamers are found to develop towards the cathode, whereas cathode streamers would be expected from the Townsend mechanisms.

The anode streamer theory is fully developed in Chapter 2. The electron avalanche first develops from cathode to anode at a speed of about 10^7 cm./sec. This results in a large positive ion space charge mainly near the anode, which creates a field of magnitude comparable with that of the main field. Accompanying ionization, there is also produced a large number of excited atoms and molecules, which in 10^{-8} sec. are emitting light of very short wave-length readily absorbed in the surrounding gas and copiously liberating photo-electrons. Those liberated near the positive ion space charge of the initial avalanche will be accelerated in the combined main and space-charge fields, and the positive ions left behind will extend the space charge towards the cathode. Thus the space-charge volume develops towards the cathode as a self-propagating streamer having a velocity probably in excess of 10^7 cm./sec. When this reaches the cathode, there is a conducting filament bridging the gap; and provided the potential is still maintained, current builds up from the cathode to the anode as a highly conducting spark or arc—the 'main stroke' of the lightning terminology. Meek suggested that the self-propagating streamer only developed when the field due to the space charge created by the avalanche reached a magnitude equal to that of the main field. Setting up the equation for this condition, Meek was able to calculate the main field strength for breakdown between parallel planes, and obtained almost exactly the experimental value. Furthermore, his formula gave good agreement with Paschen's law down to 1/8th atmosphere for a 1 cm. gap, below which it is known that time lags increase considerably above values obtaining at N.T.P. We see at once why with over-voltages applied to gaps the positive ion streamer will start even before the avalanche has reached the anode, and thus we get an explanation of the occurrence of mid-gap streamers and reduction in the formative time-lags. Branching of the positive streamer discharge is to be expected, since the incoming avalanches created photo-electrically may come from any direction roughly between the space charge volume and the cathode.

With long gaps at N.T.P., Loeb suggests that the electron avalanche cannot cross the gap in one process; after a certain stage, its progress is arrested by the field of the space charge behind it, and a positive streamer forms and progresses back to the cathode. This results in a reduction of the space-charge field and a virtual extension of the cathode, so that the electron avalanche/retrograde positive streamer process continues in steps across the gap. This is virtually the mechanism of the lightning flash from the negative cloud, and now the succession of retrograde positive streamers becomes Schonland's 'leader stroke': and the 'main stroke', instead of proceeding from cathode to anode, proceeds from ground (positive) to cloud (negative). The discharge mechanism can start also from the anode at suitable field strengths. Here electron avalanches drawn into the anode leave positive space charges which virtually extend the anode towards the cathode. As the space charge here augments the main field, sparkover voltages for large gaps are lower for positive than for negative potentials. This explanation is in line with the explanations already offered for the different appearances of the rotating camera photographs of long sparks. Both authors present theories for the cause of stepping of the lightning leader stroke. Meek suggests this is due to ageing by recombination followed by rejuvenation. Loeb suggests it is due to replenishment of lost electrons in the avalanche process.

Chapter 3 is a valuable exposition of the many spark phenomena correlated by Meek's theory. A most important feature of the calculation is the value to be given to the ratio of main field to space-charge field for breakdown to ensue. A change in this ratio of 10 : 1 only alters the calculated breakdown voltage for a 1 cm. gap by 2 per cent, and the decision as to choice of ratio was taken on the 1 cm. gap breakdown voltage. This arbitrary choice is already the subject of criticism, and further development of spark theory will almost certainly depend on the physical significance of this ratio. The chapter has been extended somewhat in a recent paper by Meek (*J. Inst. Elect. Eng.*, **89**, 335, Aug. 1942), to which interested readers are referred.

The book is well written and most enjoyable. It is unfortunate that errors were not eliminated from the text, but that was due to the separation of the authors and their preoccupation with other urgent problems. T. E. ALLIBONE.

DISCUSSING HEREDITY

Cytology, Genetics and Evolution

By M. Demerec, Charles W. Metz, Franz Schrader, Albert F. Blakeslee, Th. Dobzhansky, Clarence E. McClung, Herbert S. Jennings, William F. Diller, T. M. Sonneborn, Leon Churney, William R. Duryee, Paul S. Henshaw. (University of Pennsylvania: Bicentennial Conference.) Pp. v+168. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1941.) 12*s*. net.

THE second centenary of "The New Building" was celebrated, in more prosperous circumstances than the first, by holding a conference at Philadelphia, during September 15–21, 1940. A part of the proceedings of this conference seems to be included in the present volume. The editor's name is not mentioned; indeed, there is no introduction or preface. In default of any explanation the reviewer may perhaps attempt to fill the gap and place the papers in relationship.

To begin with, the last paper should properly come first. Henshaw's discussion of "Radiation and the Cell Nucleus" is a useful introduction to the physical side of the subject. Reference to the extensive recent American work on the biological side of the mechanism of X-ray breakage of chromosomes is, however, omitted. Jumping this gap we come to two articles on the physico-chemical structure of the cell and nucleus by Churney and Duryee. Duryee describes microdissection and other experiments with the amphibian nucleus. Most striking is his study of the formation of nucleoli and his method of expelling the nucleolus from the nucleus by changing the *p*H of the medium. Some misconceptions could perhaps have been avoided by comparison with fixed and stained preparations.

Third should be taken two articles by Metz and Schrader on chromosome structure. Schrader has evidence that a fusion of heterochromatin is perhaps the basis of the second division pairing of sex chromosomes in the Heteroptera. He does not, however, recognize the relationship of such fusion with nucleolar fusion and its distinctness from the specific prophase association of homologous genes. The situation becomes clear only when plants and animals are considered together.

The next step is shown by Demerec's article on the "Nature of the Gene", which explains the evidence for the chromomere-gene equation. It also explains the connexion between observed breaks and exchanges in salivary gland chromosomes of Drosophila, and the physiological expression of genes. The fifth step is contained in Blakeslee's and Dobzhansky's accounts of the structural changes in chromosomes found to distinguish natural races in Datura and Drosophila. The situation is indeed widely different in the plant and the animal. But it is different, not because they are plants and animals, but because geographical isolation precedes differentiation in Datura, while it may or may not follow it in Drosophila. In the one, therefore, the segmental interchanges occur as accidents; in the other the segmental inversions occur as the condition of isolation—isolation first of segments of chromosomes, and later of individuals and races.

Next we arrive at a disconnected group of papers on Rhizopods and on the ciliated Protozoa. Sonneborn deals with the anomalous genetics, Diller with the anomalous cytology, of the relatives of Paramecium. It has to be admitted that the genetics cannot be satisfactorily considered until the cytological situation becomes clearer. Diller's comparative account, however, stands for a great advance, particularly in regard to the understanding of polyploidy and autogamy. A still further advance will come when the newer methods of recognizing nucleolar and nuclear constituents are applied to the group.

Finally comes an article by McClung on the "Evolution of the Germplasm". McClung presents an abstract of the problems that confronted Lamarck, Darwin and Weismann (whose names he does not mention), together with a mixture of the solutions they offered. The account is mystical and even in places meaningless. Many will regret that, while McClung's initial discovery of the sex-chromosomes has led his disciples forwards, it has apparently led him backwards to such a point as this.

We can gather that at the time these papers were written their authors did not know of the collection that was to be made of them, for only one cross-reference occurs in the book. This is a subject, or a group of subjects, in which above all cross-reference is needed at the present moment, and a symposium should provide precisely the means to this end. A year later the Cold Spring Harbor Symposium on Chromosomes and Genes (see NATURE, **149**, 242; 1942) achieved just this object and in doing so will prove itself an important milestone in the advance of biology. The present series of papers may be taken as an easy introduction to the larger work.

C. D. DARLINGTON.

SIR JOSEPH BANKS, P.C., K.C.B., F.R.S. (1743–1820)

By JOHN D. GRIFFITH DAVIES

"THE works which this man leaves behind him occupy a few pages only: their importance is not greatly superior to their extent; and yet his name will shine out with lustre in the history of the sciences."

With those words Cuvier opened his *eulogium* on Banks at a meeting of the Académie Royale des Sciences at Paris on April 2, 1821. On such an occasion extravagant language is to be expected; but Cuvier spoke no more than the simple truth when he placed the Academy's former foreign member high on the roll of those who have made history in science; and the rightness of his judgment has not been varied in the passing of the years.

Whether Banks is to be accounted a man of science, as this term is now understood, is a debatable point. He described himself as a *botanizer*—a status now to be regarded as inferior to that of botanist. Nevertheless, there are some present-day botanists who are convinced that, when judged against the background of botanical science in his times, the botanizer Banks can justly be acclaimed a competent botanist.

Personal fortune undoubtedly made it easy for him to indulge his life-long interest in natural history. Born in Argyle Street, London, two hundred years ago this month, the son of a wealthy Lincolnshire landowner, he inherited an estate worth £6,000 a year when he came of age in 1764: a princely income in those days when money bought more than it does now, and when the State made far fewer incursions into a man's pocket. Harrow and Eton (he went to both schools), and later the "House" at Oxford, brought him no academic distinctions. Indeed, he had little liking for the customary classical studies. In 1807 he confessed to a correspondent: "I am scarce able to write my own language with correctness, and never presumed to attempt elegant composition, either in verse or in prose, in that or any other language". For that reason, he went on to say, it was improper for him to agree to become a member of the projected Belles Lettres Society: "It is fitting, therefore, that I continue to confine myself, as I have hitherto done, to the dry pursuits of Natural History".

Natural history was his absorbing interest both as a schoolboy and undergraduate. Though Oxford had a chair of botany, its occupant in Banks's time was Humphrey Sibthorpe, of whom it is recorded that he delivered but one lecture on his subject in thirty-five years. It was characteristic of Banks, always the man of action, that he should ask Sibthorpe's permission to import into Oxford the self-educated young Cambridge man, Israel Lyons, recommended to him by John Martyn, professor of botany in that University; and it was under Lyons's direction, and with the enthusiastic support of Banks and his friends, that there was revived in Oxford a lively interest in botanical studies.

Even as a young man Banks must have possessed an attractive personality. He made friends easily, even among men older than himself; and, when shortly after coming down from Oxford he acquired a town house in New Burlington Street, he entertained them with that hospitality which was later to make him famous when he removed to Soho Square. He was elected into the fellowship of the Royal Society in May 1766: among his sponsors were James West, later to be president of the Society, Charles Morton, principal librarian of the British Museum, and William Watson, distinguished both as physician and botanist.

A love of adventure was in Banks's blood. In 1766 he sailed in the fishery protection vessel, the *Niger*, to Newfoundland and Labrador. He at once proved himself to be a good sailor (later he was accused by his enemies of preferring the company of sailormen), and also a skilful collector of botanical specimens, though some of his collection was destroyed by heavy seas on the homeward journey. Two years later he sailed with Lieutenant Cook in the *Endeavour* to Otaheite to observe the transit of Venus, and thus took part in one of the memorable voyages in British naval and exploratory history. When the Council of the Royal Society petitioned the Admiralty for permission for Banks to accompany the expedition, they described him as "a gentleman of large fortune, who is well versed in Natural History", and declared that his going would be "for the advancement of useful knowledge". No doubt the petition was the more favourably received because one of Banks's Lincolnshire neighbours, Sandwich, who was particularly identified with Jemmy Twitcher of Gay's *Beggar's Opera*, was a Minister of State, and had great influence at the Admiralty.

Banks told the story of that adventure in his "Journal": read alongside the log of the *Endeavour* it gives an insight into the character of the man. He is filled with youthful enthusiasm; nothing escapes his notice. Whenever there is opportunity of shore excursions Banks and Solander, the professional botanist, are hard at work collecting specimens or observing natural phenomena. All is recorded faithfully and with commendable modesty, particularly when it is recognized that Cook looked upon him as a tower of strength in adversity. He handled the natives easily and with understanding. When an instrument is stolen it is Banks whom Cook dispatches to effect its return. Great was the disappointment among the natives when on later voyages Cook had to confess that Banks was no longer his companion. One is tempted to think that the great navigator would not have met his tragic end had Banks, in whom the natives placed such complete confidence, been at hand.

Here is not the place fully to examine the reasons why Banks did not accompany Cook on the latter's second voyage. One thing is certain: it was not because of any personal animosity between the two men. Whatever Banks's enemies said (and they said a great deal), the vessel, the *Resolution*, provided by the Admiralty did not permit of the elaborate structural alterations necessary for the accommodation of his suite. Cook, a competent sailor, bluntly said that he would not risk taking her to sea with a superstructure such as was contemplated; his superiors knew that he was right. So Banks and his party consoled themselves with a botanical expedition to Iceland, an account of which is to be found in Troil's "Letters on Iceland" (1781). This was the beginning of a life-long interest in Icelandic affairs. Not only did he serve the Icelanders by persuading the Admiralty to release their ships, held in British ports when the Danes joined Napoleon, but also he was even sounded by the Government with the view of initiating a move in Iceland to break with Denmark and place the island under the protection of Great Britain.

Banks's reputation was now firmly established, and on November 30, 1778, he was elected president of the Royal Society. The election was not universally popular among the fellows. He was young, and, so the mathematicians averred, wholly unfitted to direct the affairs "of that society in which philosophy once reigned, and Newton presided as her minister". The storm burst about him in 1783–84. He had charged Dr. Charles Hutton, the secretary for foreign correspondence, with neglect of duty. When the latter resigned, his mathematical friends, led by Dr. Samuel Horsley, a former secretary of the Society, rallied round him; and strove in open debate and in scurrilous pamphlets to oust Banks from the presidency. The details of this unfortunate dispute are too complicated fairly to be stated in a short article: suffice it to say that in the end Banks triumphed. Whether or not he was overbearing in his treatment of his colleagues, and ruthless in the conduct of his defence when assailed by those who would not yield to his will, cannot easily be decided. Certainly Banks was a masterful man; he was notoriously impatient of slipshod methods; he wanted action; he had his following, those fellows who were admitted to his brilliant receptions in Soho Square. But whatever may have been his faults, he was intensely loyal to the Royal Society, and was resolved that its fortunes should flourish under his direction. If he introduced into the fellowship (as his detractors said he did) men who had no claim to be regarded as men of science, he did so because he sincerely believed that the patronage of such men was essential for the improvement of natural knowledge; and he did not scruple to use their influence to obtain from Government the means to finance scientific research.

Organized science in Britain had no reason to repent of its choice of leader. Herschel's discovery of Uranus and his plans for the making of a large reflecting telescope, the planning of a geodetic survey of the British Isles, the Cavendish-Watt controversy over the composition of water, Young's undulatory theory of light, the need for proving the standards of weights and measures, the possibility of navigation through the North-West Passage—these were only some of the interests which agitated the scientific world during Banks's long presidency of the Royal Society. To assess his part in them is an unenviable task. As president of the Royal Society he was bound to bask in the reflected glory of the achievements of its fellows. Of chemistry, physics and astronomy he knew little (and he would have been the first to admit it); but he considered it his duty to assist all who were grappling with scientific problems; and there was no length to which he would not go in order to obtain official recognition of scientific work. Having the ear of the king, George III, he was able to lighten the privy purse of funds for the geodetic survey and the cost of making Herschel's telescope; with powerful friends at the Admiralty he could easily interest the sailors in the Society's schemes for the exploration of the North-West Passage. That the Government again came to appreciate the value of science is clearly demonstrated by the decision to provide the Royal Society with free quarters in Somerset House (1778): the improvement of that accommodation was incidentally one of Banks's first presidential acts.

Much could be written of Banks's personal relations with the king. George III was "quite a piece of a farmer": he was keenly interested in horticulture and the raising of cattle. Suspicious of the professional politicians, who not only thwarted him at every turn but also ridiculed him in their clubs, it was a relief to enjoy the friendship of a man like Banks, who stood aloof from the political arena. Together they would talk over the best methods of growing wool, even exchanging rams and ewes from their respective flocks; together they would plan the lay-out of the royal gardens at Kew, so dear to the king's heart since they had been the passion of his unhappy mother. During George III's reign nearly seven thousand exotic plants were introduced into England, and it is estimated that by far the greater number of these came to Kew through Banks's collectors.

It was impossible to enjoy the royal favour without incurring the ridicule of George III's enemies. Peter Pindar's venomous shafts were frequently aimed at Banks. He was accused of trying to amuse the Royal Society with frogs, flies and grasshoppers; he was said to have kept its fellows awake with loud raps of the presidential hammer; and, worse still, he sometimes swore in their august assemblies! Gillray's famous caricature is well known: *The Great South Sea Caterpillar Transformed into a Bath Butterfly*. "This insect," states the legend, "first crawled into notice from among the weeds and mud of the South Seas, and, being afterwards placed in a warm situation by the Royal Society, was changed by the heat of the sun into its present form. It is noticed and valued solely on account of the powerful red which enriches its body and the shining spot on its breast; a distinction which never fails to render caterpillars valuable." The king's enemies laughed heartily at Gillray's work—and, incidentally, so did Banks!

The caricaturist had, however, laid bare one of Banks's weaknesses. There is no doubt that he was inordinately proud of the K.C.B. which the king bestowed upon him in 1795; nor was he less proud of his admission to the Privy Council two years later. At all functions, whether official or semi-official, he appeared in court dress—a splendid figure of a man with the red sash across his body and the order conspicuously displayed on his breast. In that garb he presided over the Council and ordinary meetings of the Royal Society, sitting in the chair (his own gift) which is still used by the president.

Another of Banks's weaknesses was his dislike of all attempts to found new scientific societies. He believed that they must inevitably weaken the Royal Society; and that was not to be tolerated. If they were content to remain associations of scientific men, dependent upon the Royal Society, all well and good: otherwise they were to be opposed with all the powers at his command. Yet he helped to found the Linnean Society in 1788, and was its first president; he was also associated with the founding of the Royal Horticultural Society; it was in Banks's house in Soho Square that the famous meeting was held which resulted in the founding of the Royal Institution. On the other hand, he withdrew from the Geological Society when that body refused to become a dependency of the Royal Society; and, at the close of his life, he resisted most resolutely the move to found the Royal Astronomical Society, even persuading the Duke of Somerset, designated as first president, to refuse to accept office.

After his voyage with Cook, when both New Zealand and Australia were visited, Banks was looked upon by king and ministers as *the* authority on Australasian affairs; and there is positive evidence that he refused high political office in order to leave himself free to watch over the destinies of the young colony, in whose future he had unbounded faith. When Europe was distracted by the Napoleonic wars he could write to Hunter, the governor of New South Wales: "I see the future prospect of empires and dominions which now cannot be disappointed. Who knows but that England may revive in New South Wales when it is sunk in Europe." To those who were entrusted with the government of the newly established colony his advice and encouragement were invaluable. Phillip, Hunter, King and Bligh, fighting manfully to give New South Wales an orderly government and thwarted by the professional soldiers who augmented their meagre pay by trafficking in rum, poured out their troubles to him; he reciprocated by doing everything in his power to smooth over their difficulties. In Bligh, that most maligned of men, he never lost confidence. Banks knew him for an expert sailorman, a wise and just governor; he could appreciate, perhaps better than Bligh's traducers, the courage which had been required of the latter when he navigated the loyal men of the *Bounty* through the Timor Sea. And all the time, intermingled with his words of counsel and encouragement, were requests for specimens of plants and any information which might be of value to men of science. It was not to be a one-way traffic in plants. "My business," said Banks to Hunter, is to be "the encourager of the transport of plants from one country to another." The young colony needed a supply of "useful plants"—hops, for example, were to be shipped to New South Wales in the hope that beer would diminish the consumption of rum; and it was Banks who tried to ensure that the colonists' needs were supplied. There were, of course, disappointments. Consignments of specimens were sometimes lost at sea, on homeward and outward voyages, and official support was not always forthcoming in London; but Banks never lost heart; and he could boast to Hunter that "we shall before it is long see her [Great Britain's] ministers made sensible of its [New South Wales's] real value". It is not to be wondered that our kinsmen in Australia look upon Banks as the 'godfather' of their country, and have zealously collected a great wealth of his papers.

Banks was unquestionably a great European. In London his name was a household word; even the humblest citizen knew of the "great Sir Joseph" who lived in Soho Square. Abroad, men of science looked upon him almost as the protector of all scientific effort, especially when the Napoleonic wars interrupted the free exchange of ideas between England and the Continent. Cuvier's tribute to his brave, and successful, endeavours to raise science high above the quarrels of nations is not an unfitting conclusion to this memoir. "During the long period of two and twenty years," said Cuvier, "in which war extended its ravages to every part of the two worlds, the name of Banks was in all places a palladium to such of our countrymen as devoted themselves to useful researches. If their collections were seized, they had only to address themselves to him to ensure their restoration; if their persons were detained, the time occupied in acquainting him with the fact was the only delay which was interposed between them and liberty. When the seas were closed in upon us on all sides, his voice opened a passage to our scientific expeditions. Geography and natural history are indebted to his solicitude for the preservation of their most valuable labours:—but for him our public collections might now, and perhaps for ever, be deprived of the riches which adorn them."

Banks died at his house at Spring Grove, Isleworth, on June 19, 1820: he was buried, as he wished, with neither pomp nor ceremony, in the graveyard of Heston parish church.

PRODUCTION GENETICS IN SWEDEN

By Dr. C. D. DARLINGTON, F.R.S.

NATIONS often have to rely for their independence on the independence of their food supply. This principle is as well understood in Sweden as in Great Britain, and for similar reasons. Since the War of 1914–18, however, Sweden's position has been greatly improved. The annual yields of wheat and sugar-beet have been increased to the point at which the country is just self-supporting. The most important factor in this increase has been the improvement in the farmer's seed by plant breeding; indeed, one quarter of the wheat and nearly one half of the sugar harvest may be put down to the use of improved seed.

Sweden might seem to be a particularly grateful field for the plant breeder because, like Canada and the U.S.S.R., it lies on the northward margin of cultivation; any slight change in hardiness or growth-rate or light-response which pushes the limit of growth slightly farther north therefore throws open a vast new territory to cultivation. On the other hand, as we shall see, the severity of the Swedish climate does not allow the plant breeder to win his victories without a struggle. What these victories amount to I have recently had the privilege of seeing.

The foundation of Swedish success in plant breeding lies in the small village of Svalöv in Skåne, the richest and southernmost province of Sweden. At this centre we find three partners working together. The youngest of the three is the Institute of Genetics of the University of Lund, some twenty miles from Svalöv. This is a department for teaching and research. It was established for Prof. Nilsson Ehle in 1927 and is now directed by Prof. Müntzing. The second partner is the Svalöv Plant Breeding Institute, formerly directed by Nilsson Ehle and now by Prof. Akerman. This Institute is immediately responsible for the production of new varieties, but is, at the same time, concerned with long-term research and houses a part of the Institute of Genetics. The third partner is the Swedish Seed Company, which has the monopoly of maintaining the stocks and selling the seed of the Svalöv varieties and controls each step between selection and marketing. Without this monopoly it was realized that the maintenance of scientific standards could not be guaranteed. The triple organization, now occupying about three thousand acres, arose at first from a farmers' union, but it is now supported and partly controlled by the Government.

This system has developed during the last fifty years and has grown as the field of possible activity has extended and the numbers of crops that have seemed worth while improving have increased. It began with cereal breeding and with the union, on one hand, of the new genetic analysis of quantitative inheritance in terms of cumulative factors by Nilsson Ehle and, on the other hand, of the practical understanding of the plant breeding problem by the first director, Hjalmar Nilsson. This union we now see bearing fruit equally in the practical and the theoretical field.

The first development of the Svalöv organization was the formation of subsidiary stations to meet the local needs of the main climatic regions of Sweden. For example, the Undrom station deals mainly with herbage plants but also with potatoes, while in the far north (latitude 66°) the Luleå Station produces new types of barley and oats. The station at Ultuna, near Uppsala, is of the first importance, and Ultuna has recently been made the site of a centralized agricultural college for the whole of Sweden, a choice which arises not from its central geographical position but from its marginal agricultural position. The new problems and the most difficult ones are on this northern margin. Here under Prof. Turesson some of the most important work is concerned with genetic acclimatization.

The second development has been the formation of specialized stations for particular crops. For example, at the beginning of the War the shortage of textiles brought home to the authorities the importance of fibres, and the flax research was transferred to a new laboratory under Dr. Granhall at Månsabo, near Svalöv. Just as the wheat-breeding department has its complete milling and baking installation, and the sugar-beet laboratory its complete extraction and assaying equipment, so for flax a complete retting installation has been set up, together with special apparatus for retting small selection samples. The industrial equipment necessary as a foundation for plant breeding is never spared.

Sweden's abundance of forests could not long be overlooked where the possibilities of plant breeding were considered. In 1936 a new research station was established by a Society for Breeding Forest Trees. It lies in fifty acres of experimental ground at Ekebo, near Svalöv. An expedition led by Prof. Turesson in 1938 provided a valuable collection of forest-tree seed from North America as a foundation for the work of acclimatization and hybridization.

Under Dr. Nils Sylvén, this work has already gone far. Four regional branch stations have been set up. A genetic survey of Swedish forest trees has revealed a prodigious range of variation in usefulness (just as one sees in Great Britain) both within communities and between them. The ecotype principle is singularly well demonstrated in the differences within species in regard to long- and short-day habit, for when transplanted to a different latitude the unadapted individual is obviously and entirely useless.

A special form of selection has resulted from the discovery of triploid aspens with as much as twice the growth-rates of the neighbouring diploid trees. Many of the later examples have been discovered by farmers and foresters who had been told to look out for them. These valuable trees are being propagated for their own localities, and tetraploids have also been obtained from them. The discovery of these forms has led to the systematic use of colchicine, which has been successful in producing tetraploids in Sequoia, Larix, Pinus and Abies. Artificial lighting, refrigeration and special grafting methods are being used to shorten the work of breeding and propagating.

Naturally, fruit being something of a luxury in Sweden, fruit breeding has been the last problem to be tackled, but two factors have lately directed attention to its importance. First, the damage done to the orchards in Sweden—only less serious than in Finland—by the three severest winters ever recorded, shows the necessity of producing native fruits selected for the Swedish climate. Secondly, the value of vitamin C in a country cut off from southern fruits is obvious. Valuable work has indeed been done in surveying the native rose population for its ascorbic acid content, and maintenance of vitamin content is regarded as an important object of potato breeding.

The origin of the fruit work at Svalöv is typical of the confident purpose of Swedish plant breeding. Triploid apples are in general not only larger but also later keeping and richer in vitamin content than diploids. In order to produce them regularly it was necessary to have tetraploids. Half a million natural seeds of the best triploid varieties were sown. All of them, of course, would be crosses with cultivated diploids. From them twenty-eight tetraploid seedlings—recognized by their larger stipules—have been obtained in the last five years. With this initial endowment the new fruit-breeding stations which are being set up at Alnarp and Balsgård will have a promising foundation.

Instead of relying on such chance origins, however, the plant breeder can now produce polyploids at will by the use of twin seedlings, collected by the seed-testing stations, by heat, and especially by colchicine treatment. These methods have been taken up with enthusiasm and success in Sweden. Tetraploid forms of clovers, lucerne, herbage grasses, barley, rye, flax, potatoes, sugar-beet and other crops have been produced and are being tested; some have already been proved of practical use. Octoploid wheat-rye hybrids, first raised in the U.S.S.R., are now regularly produced by the doubling of crosses between suitable parents for different conditions and purposes. The selection of their derivatives has made available a large range of forms of good baking quality and high yield and hardiness. In fact, a new grain crop of special value for Sweden and other countries has been created, the first such invention for three thousand years.

Research in Prof. Müntzing's department has indicated the mode of action of colchicine in arresting cell-division and doubling the chromosomes. It has also shown the nature of the anomalous systems of reproduction in herbage grasses, particularly Poa, where either meiosis, or fertilization, or both, may be omitted, with the production of new forms; where secondary polyploids breed true; and where pseudogamy depends on the fertilization of the endosperm nucleus alone. Dr. Å. Gustafsson at Svalöv has succeeded in unravelling another anomalous situation in the Canina roses by crosses which have produced new types of reproduction. These investigations are revealing principles of permanent importance in plant breeding. Similarly, the study of the nucleic acid cycles of crop plants which is now being linked up with Caspersson's cell physiology in Stockholm will lay the foundation of new methods of plant breeding.

Geneticists have long had misgivings about the value of X-ray mutations in plant breeding. Gustafsson, however, has made extensive trials and selections of the progeny of X-rayed barley in the third and fourth generations. From the variety Golden Barley he has obtained selections with as much as 10 per cent increase of yield. Whether or not these forms are directly utilizable it is clear that they provide the material of future improvements by recombination. The use of the X-ray method is therefore being extended.

Animal breeding is generally slower than plant breeding and its advantages take longer to prove. Moreover, in Sweden, as in Great Britain, superstition is deeply embedded in the minds of the breeders, although it is not, as here, incorporated in official handbooks. The Swedish Animal Breeding Institute with its well-equipped laboratories is situated on an extensive stock farm at Wiad, near Stockholm. Here Prof. Bonnier has set about reducing the difficulties of the problem by applying the latest technical devices. Artificial insemination is used to make rapid progeny tests of young bulls so that the same bulls, and not their progeny, can be bred for stock improvement. Special tests, again with artificial insemination, have been made for the choice of parents in hybrid-vigour crosses of poultry. New breeding systems have been established for preserving standardized and uniformly cross-bred stocks of poultry by using mixed sperm. These methods are influenced by the hybrid-vigour technique applied with pre-eminent success by Rasmusson to sugar-beet, and to maize in the United States. Finally, the possibilities of physiological experiment with monozygous twins have been exploited by a national collection of such twins in cattle. This deserves special consideration.

One half per cent of all cattle births are twin heifers. To determine which of these are monozygous a preliminary questionnaire is put to the farmer. Those passing this test are bought and submitted to Kronacher's nose-print and hair-whorl tests. Of the first 215 applications seven pairs fulfilled the conditions of identity. In this way nearly a hundred pairs of monozygous twins have now been collected at Wiad from all over Sweden. With these it has been possible to set up physiological experiments covering the practical problems of nutrition and maintenance. From these experiments the genetical variable has been removed. Already questions have been answered with a certainty which could not otherwise have been attained at fifty times the cost. Further, the answers are of importance far beyond the field of husbandry, especially, of course, in medicine.

The lessons of practical breeding—or production genetics as we may call it—in Sweden have their lessons for Great Britain with its vast responsibilities for farm, forest and fruit crop production at home and overseas. The results depend on a policy consisting of the following coherent elements:

(1) Genetics is taught in the universities;

(2) Posts are available in genetic research for the ablest university students;

(3) Men are therefore available to teach in the universities who have done research in this subject and thus actually understand how it works.

This is a train of events which a little thought shows is indeed necessary for the healthy development of any science. But this is only one side. The university departments carry on their work in close collaboration with the applied departments of agriculture and medicine and with the research stations. This leads to an integration of subjects and methods. It leads to a realization of the use of statistical, chemical and cytological techniques in genetics, and of genetical techniques in physiology. Finally, the research stations benefit by a direct flow of ideas and of trained personnel from the universities, and themselves in consequence conduct long-term or 'pure' research of value.

This integration is responsible for what may be described as the engineering method of Swedish plant and animal breeding: a bold combination of scientific basis and long-term planning, with a practical purpose and with practical collaboration. The practical collaboration depends again on the Swedish farmer or medical man himself understanding, as a result of education and propaganda, what profit can be gained by using the latest scientific methods. Such a system and such results do not arise by individual effort or accidental whim. They depend upon an instructed national policy.

ADVANCES OF CHEMICAL KINETICS IN THE SOVIET UNION

By NIKOLAI SEMENOV

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[The school of N. Semenov is well known to physical chemists throughout the world. Its outstanding contribution has been the application of the theory of branching reaction chains to problems of combustion and explosion. In 1935 Semenov himself published a standard treatise on "Chemical Kinetics and Chain Reactions". His ideas have provided a comparatively easy way through many complex and mysterious phenomena. The following article describes how the theoretical and practical work of his school has developed.—Editors, NATURE.]

UP to the twenties of the present century, 'chemical kinetics', or the science of the regularities underlying the course of chemical transformations, was largely in obscurity. But from this time onwards it becomes one of the predominating trends of physico-chemical studies.

As regards homogeneous chemical processes, the concepts of van't Hoff and Arrhenius were to undergo considerable modification. The idea was advanced that the reactions proceed through a number of stages, or intermediate products such as free atoms and radicals or particles excited by electrons. The work of Bodenstein, Haber, Christiansen, Polanyi, Lind, Bäckström and others during 1913–28, especially experiments on the formation of hydrogen chloride and bromide, was the first to suggest the new ideas and the methods of computing the velocities of these reactions. It is in connexion with these studies that the first idea of chain reactions was inaugurated.

It will, however, be noted that no general significance was attached to chain reactions up to 1927. They were considered as confined to very few individual cases.

The situation changed appreciably in 1927, after the publication of the first papers from the Institute of Chemical Physics of the U.S.S.R., and, soon after, of quite independent studies by Hinshelwood and his school in England. It was shown that chain reactions represent a large group of chemical transformations. A theory of chain reactions was developed, new and stimulating ideas were introduced regarding branching of chains and their being cut off on the walls of the vessel: the principal laws of these reactions were deduced and verified experimentally.

From 1928 onwards, these new studies in the domain of chain reactions were discussed at physico-chemical congresses and conferences throughout the world, and they have given rise to numerous experimental studies. During 1934–35, Semenov's monograph "Chain Reactions" was published in Russian and in English. This book reviews all the evidence bearing on chain reactions and gives an exhaustive and systematic discussion of the theory. In all monographs and books on chemical kinetics, the doctrine of chain reactions occupies a significant place. During 1941–42 an article by Semenov was prepared for press on the general theory of complex reactions, in which a strict mathematical treatment of the theory of chain reactions was presented in a new general form.

The theory of chain reactions postulates that in the course of chemical transformations there appear extremely unstable energy-rich intermediate products (atoms, radicals, unstable peroxides and other labile products). The urgent necessity then arose of determining the nature of these products. The lack of suitable methods still rendered this task almost impossible, and this most important problem could be solved only in one or two cases.

In 1937, the problem was taken up in the laboratory of Prof. Kondratiev (Institute of Chemical Physics). It was shown that, in rarefied flames of hydrogen, free hydroxyl is formed in very great quantities (up to 0·1 per cent of the initial hydrogen) as an intermediate product of oxidation of hydrogen. The amount of hydroxyl is hundreds of thousands times greater than that corresponding to the temperature of the experiment. Kondratiev determined the hydroxyl by a specially devised absorption spectrum method. He also detected CS and SO radicals in the oxidation of carbon disulphide.

Of great interest also is the work of N. Emanuel (1939–42), in which large quantities of SO were shown to appear in the course of carbon disulphide oxidation, and the role of this active intermediate product was established.

A specially detailed study was made of the kinetics of the oxidation of hydrogen and of various hydrocarbons. Naboldin's work (1932–42) showed that the theory of chain reactions accounts for the whole peculiar course of the reactions not only qualitatively but also quantitatively. Concurrently with studies in other countries, the intermediate products of hydrocarbon oxidation were explored in detail, since owing to their relative stability they can be detected with less difficulty. By 'freezing' the reactions at a given stage, Prof. Neuman detected and determined quantitatively by various methods (in particular, polarographic methods) different intermediate products (peroxides, aldehydes, etc.) appearing in the course of oxidation of hydrocarbons.

The phenomenon of cold flames of hydrocarbons, which is very interesting and significant in connexion with detonation in the petrol engine, was subjected to an especially detailed analysis by Prof. Neuman and his collaborators at this Institute (concurrently with the English school of Bone).

Another important branch of chemical kinetics deals with the theory of flame, where chain reactions, as shown in this Institute, mostly play a significant part.

In the twenties of the present century, no satisfactory theory of burning existed—a direct result of the backwardness of chemical kinetics. The work of the Institute of Chemical Physics introduced into the theory the major element, namely, the chemical kinetics of the reactions. This resulted in the establishment of the fundamentals of a theory which accounts for all the principal phenomena associated with burning in gaseous systems. Most of the results obtained are discussed in Semenov's papers (1940–41) under the general title "Theory of Burning", and in articles by Prof. Seldovich.

In 1927 Semenov formulated the now universally acknowledged theory of thermal explosion. At the same time he defined another type of inflammation, namely, the chain type. It was shown experimentally by Sagulin and others how to differentiate between the two types of explosion.

In 1931 the theory of the 'degenerate' explosion was developed, and also the theory of inhibition of explosion applicable to those cases where slow development of the branching chains (chain 'degenerate' explosion) results in an acceleration of the reaction to the point of thermal ignition. This accounts for the induction period, which sometimes lasts scores of minutes before explosion sets in. These phenomena have been studied in detail in the U.S.S.R. and elsewhere, the results being in full conformity with the theory. Degenerate explosions occur, in particular, in the oxidation of hydrocarbons. The great significance of the induction phenomenon and of the laws studied at the Institute of Chemical Physics on the theory of detonation in the internal combustion engine was soon realized, accounting for the interest aroused by these studies among engineers. All modern theories of detonation in internal combustion engines stand in close relation to the theory of burning, which was largely developed in this Institute.

Prof. Sokolik and his associates not only extended the theory in this direction but have also drawn from it a number of practically important conclusions.

The theory of the slow propagation of the flames with reference to chemical kinetics was first developed by Lewis in the United States (1934). Seldovich and Frank-Kamenetzky of this Institute extended this work by developing a consistent theory of the slow propagation of flame. The validity of the theory was shown experimentally by Baliaev (burning of liquid nitroglycerine), by Semenov and Seldovich (burning of carbon monoxide) and by Kokachashvili and Seldovich (burning of a mixture of hydrogen and bromine).

Just as with thermal self-ignition (calculation of the temperature of self-ignition from kinetic data of the slow process), so in the present case we were able to calculate the absolute value of the rate of flame-propagation in addition to its dependence on temperature, pressure and composition. Seldovich also developed the theory of various practically important phenomena such as limits of inflammation and detonation. He also completed the theory of the detonation wave, which previously had not been brought into relation with the rate of the actual chemical process.

In this way the phenomena of burning were correlated with chemical kinetics. Burning differs from slow reaction only in one respect—the powerful liberation of heat, and the hydrodynamic phenomena associated with it, influence profoundly the rate of the chemical process. To take these influences into account offers great mathematical difficulties. In developing the theory these have been overcome to a considerable extent, and the formulæ derived from the theory have been verified by experiment.

Concurrently with studies on the burning of gaseous systems, Prof. Khariton's group carried out extensive work on the burning and detonation of explosives. The results obtained are also of fundamental importance. Here also many new phenomena have been observed, and the theory has been clarified, but this domain still requires further theoretical work.

It cannot be assumed that we have reached complete certainty in the theory of burning, or that no unsolved problems will remain in this field of research. Here, as in the theory of chain reactions, a solid basis has been laid, the physical meaning of the processes has been clarified, and the method of approach established. Nevertheless, each individual reaction requires a special study, its specific character being different.

In this way we have worked step by step during the last twenty-five years in developing chemical kinetics in close contact with the English and American men of science who have frequently attended our conferences or sent us their papers.

Now our work has been interrupted. Many young workers of this Institute voluntarily joined the army during the first days of the War; one of my closest associates and followers, P. Sadovnikov, whose name is known among scientific circles of Great Britain, has been killed. But the majority of our collaborators are still in the laboratories of the Institute, where work has been greatly intensified.

HYDRO-ELECTRIC DEVELOPMENT IN SCOTLAND

On October 27, 1941, the Lord Advocate for Scotland, then the Right Hon. Lord Cooper, was appointed chairman of a committee of five to inquire into a report on hydro-electric development in Scotland. The report now issued* is dated August 24, 1942—so the Committee wasted no time. The Committee recognizes that hydro-electric planning is a matter for many years ahead—though it may not be out of place to remark that the national grid in Great Britain is an established success for war as well as peace conditions.

In the historical survey, the record of the last twenty years, with its six successive abortive promotions, comes boldly and badly into the picture. All major issues of policy, both national and local, have tended to become completely submerged in the conflict of contending national interests. But even governments do not escape if their policy is that they will neither develop the resources themselves nor allow anyone else to do so.

Excluding all burghal areas, the overall density of population on the mainland of the Northern Area is less than 20 per square mile. Northern Scotland is the only part of Great Britain not covered by the Grid scheme. The Committee finds that for such an area the policy embodied in the 1926 Act (which led to the formation of the Central Electricity Board) is essentially inappropriate and inapplicable. The progress of the Grampian Company, the control of which was obtained by the Scottish Power Company, in 1927, is traced. By supplying 106 million units per annum to the Central Electricity Board, the Grampian Company has an assured market to enable it to embark on a general supply in an extensive and sparsely populated territory. In 1940, the units sold, other than to the Central Electricity Board, totalled 63 million at an average of 1·55*d*. per unit. Here, then, is indicated a practical way for development. The Committee considers these results to justify the decision of the Electricity Commissioners and Central Electricity Board in 1931 to leave the development of this area to the Grampian Company.

Commenting on the criticisms against the Grampian Company, the report shows a sympathetic appreciation. Even so, doubts may still exist. On one occasion, when the present writer was visiting the Loch Rannoch and Tummelbridge Works, it struck him as strange to see two joiners making a coffin by candlelight in a house in the village of Kinloch Rannoch.

In the existing state, it is stressed that it will be essential at the earliest possible date to provide a substantial new source of power in the extreme north of the Grampian territory, to meet normal expansion. To construct a large steam station in a district so remote from coal and so rich in water-power would involve a major error of misplanning. It is not agreed that the cancellation of the bulk supply to the Central Electricity Board would solve the problem, both because of the effect of the loss of the contract, and the fact that Loch Rannoch and Tummelbridge Works have been designed for a 50 per cent load factor and not for supplying a general demand.

In the study of comparative costs of steam and hydro-electric generation, attention is directed to the rising price of coal in recent years, and in the fall in the basic rate of interest—the main components in the cost of electricity generated from steam and water respectively. On the financial side, the Committee considers its recommendations preferable to the provision of an equivalent capacity of new steam plant. Any likely improvement in water or steam-power technique is unlikely to influence the position. Provisional estimates disclose some seventy favourable schemes in the Northern Area capable of yielding not less than 4,000 million units per annum, or 450,000 kW. continuous.

Of the opposing theories for revitalizing the Highlands, the Committee regards the introduction of modern industries in which an abundant supply of cheap electricity is indispensable as the only means of securing a prosperous population in the area. These industries are electro-chemical and electro-metallurgical: calcium carbide and cyanamide; reduction or refining processes for aluminium, copper, zinc, vanadium and cadmium; the ferro-alloys. The defeat of the Caledonian Power Bill is regarded as a tragic mistake, not only for Scotland but also for Great Britain. Assuming that these industries on a substantial scale are essential to Great Britain, northern Scotland offers the only solution. By suitable planning, natural beauty can be preserved. The Committee challenges the critics to offer any other scheme to arrest the growing decay in the Highlands.

From independent computations, it is found that the ultimate local demand for general supply represents about 8 per cent of the ultimate power capable of development; consequently the position for the local population would be adequately safeguarded. In the long-term plan of development, the national grid forms the indispensable background as a market for surplus power.

The Committee's recommendations include the creation of a non-profit-earning, public-service corporation to work in close partnership with the Central Electricity Board. This new corporation would be responsible for the further development of electricity generation, transmission and distribution in the Northern Area. The corporation should attract to the Highlands a share of the industries demanding abundant and cheap power, develop such further power as may be required, and develop on an experimental basis isolated schemes in isolated districts. Local requirements should be given priority.

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* Scottish Office. Report of the Committee on Hydro-Electric Development in Scotland. (Cmd. 6406.) Pp. 38. (London and Edinburgh: H.M. Stationery Office, 1942.) 9*d*. net.

The Committee also considered the safeguarding of fishery interests; the need for compulsory powers, the present inequitable valuation and rating of hydro-electric undertakings, and the preservation of the amenities.

From the foregoing digest of the report, it will be seen that the Committee has not only considered all relevant matters, but has also taken into account the views of opposing interests. A careful examination of the report leads to the conclusion that this is the first complete study that has been made of this matter, and that the general conclusions reached are the only sound ones possible.

S. Parker Smith.

OBITUARIES

Dr. C. Tate Regan, F.R.S.

Charles Tate Regan, formerly director of the British Museum (Natural History), who died on January 12, was born at Sherborne in February 1878 and was educated at Derby School and Queens' College, Cambridge. The choice of Derby was probably influenced by the fact that his parents were professional musicians, for the head-master at that time was J. R. Sterndale-Bennett, a son of the composer, and music took a serious place in the life of the School. The appreciation of great music thus inherited and cultivated gave Tate Regan great pleasure in later years. It was L. J. Fuller, the science master at Derby, who first suggested a career at the Natural History Museum to the boy, among whose interests natural history was already prominent, and Tate Regan stayed a fourth year at Cambridge to wait for a vacancy to occur at South Kensington. At Cambridge he studied under Sedgwick, and he worked and played with equal zest. He played both Association and Rugby football, and was a good sprinter, hurdler and jumper. At this time he was uncertain whether to specialize in plants or animals, but of one thing he was sure, that his interest would be in the structure of living organisms, and its bearing on their relationships and evolution.

In 1901 Regan joined the staff of the British Museum (Natural History). Günther, who was then keeper of zoology, advised him to specialize in fishes, and he joined G. A. Boulenger on this group, starting, at Günther's suggestion, with a revision of the family Stromateidæ, which was the subject of his first paper (1902). Boulenger had just received the proofs of the "Cambridge Natural History" volume on fishes, and asked his young colleague to look through them. Regan suggested that the Gadoidea were wrongly placed and Boulenger challenged him to prove it, finally accepting Regan's arguments (published in 1903) and altering the book accordingly. Regan would tell this story in later years, wondering at his own temerity.

From this time on, every year saw a long list of titles under Regan's name in the *Zoological Record*, and one is left amazed at the mental energy that allowed him to work on so many lines at once. His most important contribution to ichthyology was the series of papers on the major classification of living fishes, beginning with the "Classification of the Selachian Fishes" (1906) and continuing with the Teleostean orders and sub-orders, which were treated severally in some score of papers appearing in the *Annals and Magazine of Natural History*, mainly during the years 1911–13. This work was based on the study of a big collection of dried skeletons and on spirit specimens, and was written in a form and style so concise as to give little idea of the amount of research behind it. It is summarized in articles on selachians and fishes in the fourteenth edition of the "Encyclopædia Britannica", and presents a classification which is accepted as a basis by serious ichthyological workers all over the world.

In 1911 there appeared a work of a very different type, "The Freshwater Fishes of the British Isles". This is perhaps the most fascinating of Regan's works, combining as it does the results of intensive studies in the museum with knowledge gained in delightful days spent angling in the rivers and streams near his home in Dorset, and in visits to the English and Scottish lakes that harbour the relict char. At once authoritative and readable, this is a model book of popular natural history.

It fell to Regan's lot to write the section on fishes in the "Biologia Centrali-Americana" (1906–8) and to report on the fishes of the Antarctic expeditions of the *Scotia* (1913) and *Terra Nova* (1914, 1916). From these results syntheses were made which increased considerably our knowledge of the laws governing the geographical distribution of fishes. His conclusions on this subject, too, are gathered together in an "Encyclopædia Britannica" article. Regan's systematic revisions of families are many, and in every case have that masterly quality which has put subsequent work upon a sound basis, and has been a powerful influence in keeping the standard of systematic ichthyology high.

I first met Dr. Regan in 1921, when as a student I visited the Museum to learn something about the classification of fishes, and received unstinted help. Regan had then just become keeper of zoology. When, in 1927, he was appointed director, he found that administrative duties left him little time for scientific work. He was able, as always, to do a great deal in the evenings, but he needed a collaborator who could deal with the practical work on the collections all day, allowing him to follow it in what time he could spare, and in the following year I was appointed as his scientific assistant. He had already, in 1925, dealt with the deep-sea angler-fishes of the first *Dana* expedition, and had described for the first time the dwarfed and parasitic males of this group. He was now about to tackle the *Dana* Stomiatoid fishes, and had also large collections of African Cichlidæ to work out. I soon understood that I was highly privileged to work upon such material under the guidance of such a man, and my admiration for his outstanding brain, his memory, his enthusiasm and drive grew with our association. With the second collection of *Dana* deep-sea angler-fishes, we elaborated together Regan's earlier discovery of the parasitic males. Parr's announcement that some males were dwarfed but free-swimming came when we were already working on this collection, and was not a surprise, and the *Dana* material made it possible for us to relate the free males to their extremely dissimilar mates. This work gave Regan special pleasure, as also did his earlier discovery of the nature and structure of the complicated copulatory organ of the minute East Indian fishes of the family Phallostethidæ. The latter work appeared in 1916, the year before his election to the Royal Society at the age of thirty-nine.

Although he was a good systematist, Regan never mistook the minutiæ of taxonomy for an end in themselves, and his outlook is well summarized in the following quotation from his address on "Organic Evolution" before Section D (Zoology) of the British Association in 1925: "Every good systematist must feel some satisfaction when he has written a diagnosis that is diagnostic, or has made a key that will work; but this satisfaction is small compared with that which he feels when he has reason to think he has settled the position of some doubtful form, or has discovered the origin of a group and the lines of evolution within it. The main interest of systematic work lies in the fact that it is a study of the results of evolution, and that from such a study one may hope to get some light on the meaning of evolution".

Regan found in the fishes ample scope for his energies, but his interests extended beyond, and especially into other vertebrate groups. His interest in the geographical distribution of animals led him to suggest to other specialists lines of research on the interrelationships of frogs and the classification of mammals. He was convinced, moreover, that false ideas were prevalent as to the origin and classification of the primates, including the ancestry of man, and in 1930 he published a preliminary statement of his views. He followed this by an elaborate investigation into the structure and relationships of insectivores and lemurs, and left unfinished manuscripts and drawings which it is greatly to be hoped will be put into order and published. Of recent years, too, he had embarked on a general classification of the fish-like vertebrates, and, to clear up a doubtful point, had undertaken an investigation of some fossil forms. This paper also was left unfinished.

In addition to his scientific work, Regan performed important services for the British Museum (Natural History) as keeper of zoology and director. His first duty on taking the directorship was to give evidence before the Royal Commission on Museums, and as a result of this the Commission recommended increases of staff and of buildings. The increase in staff, though delayed, was finally accomplished, but the financial crisis of 1931 interfered with the plans for building to such an extent that the War found them still only partly carried out. It is sometimes thought that Regan had little interest in the exhibition side of the Museum. This was not so, but his large-scale ideas were bound up with the new building plans, and were never even put on paper.

Regan had the gift of lucid expression, founded on clear and concentrated thinking, and he enjoyed talking on a subject that interested him. He was a member of the Royal Society Dining Club and often entertained his fellow "royal philosophers" over their port with an account of his latest discovery, illustrated by specimens and drawings. Many an impromptu lecture, which would have delighted a class of students, has been reserved for my unworthy ears at South Kensington, illustrated by drawings on the back of an envelope or an empty cigarette packet.

Tate Regan was an honorary fellow of his College, received the degree of D.Sc. *honoris causa* from the University of Durham, and was *Academico Honorario* of the University of La Plata. He was a foreign member of the Royal Danish Academy, of the American Academy of Arts and Sciences, and of the American Society of Ichthyologists and Herpetologists; the Geoffrey de St. Hilaire Medal was awarded to him by the Société Nationale d'Acclimatation de France.

Regan's outstanding qualities were generosity and frankness, which endeared him to his friends, and an enthusiasm and energy which made him, like the sprinter he was in his youth, go all out for some desired objective, and left him the victim of a too severe disappointment if it failed him. He was a keen gardener and enjoyed watching a good game of football or an athletic contest. His friends mourn a rare and stimulating companion.

Sincere sympathy goes out to Mrs. Regan and their four children, one of whom is now a prisoner of war.

E. TREWAVAS.

Dr. Nikola Tesla

NIKOLA TESLA, who died on January 7, was born in 1857 at Smiljan in Croatia. His father, a Serb, was a clergyman of the Greek Church; his mother is remembered as very inventive and is credited with making improvements in churns, looms and other rural machinery. Nikola, while at school, began to make electrical experiments, and finished his formal education in the engineering faculty of the Graz Polytechnic School. After a period in the Government telegraph department at Budapest, he joined the Edison concern in Paris and went to the United States about 1883. Here he worked under Edison for a time, but soon set up his own firm for the manufacture of arc lighting plant.

At this period the applications of electric power in industry were effected mainly by direct current, but many inventors were attacking the problem of making motors suitable for use with alternating current. Tesla in the United States and Ferraris in Italy each published in 1888 the results of several years of independent work on motors utilizing rotating magnetic fields produced by two-phase currents. Both inventors envisaged machines in which the rotor is propelled asynchronously by means of currents induced in it by the rotating field, and Tesla described also motors in which the rotor is pulled round in synchronism with the rotating field. Neither type need employ brushes or commutators. These rotating-field motors, together with the introduction of polyphase currents, proved to be the solution of the problem of using alternating current in factories. In addition, by 1890, Tesla also invented methods of starting and running motors on single-phase current. His designs were so sound that his larger machines attained efficiencies of 95 per cent. Having completed his task, he disposed of his patents to the Westinghouse Company and dropped the subject.

Hertz's work was directing attention to high-frequency alternating currents, so Tesla turned to the problem of generating these currents on an engineering scale. First he designed and built a succession of alternators, and by 1891 attained a frequency of 30,000 cycles per second. He studied the properties of these currents in circuits possessing distributed inductance and capacitance, and developed tuned coupled circuits for enhancing their voltage by resonance. For higher frequencies he employed the discharge of condensers through induction coils, obtaining big powers by aid of rotating dischargers or magnetic blow-outs at the spark gap. On coupling the primary circuit to a resonant secondary circuit comprising metal areas, large flaming and streaming ionization currents were obtained in air and in Geissler tubes. Ionic bombardment was observed to produce brilliant phosphorescence, and sometimes fusion, of solid matter.

But Tesla's main purpose was the transmission of power and messages across space. In 1892 and 1893 he developed his scheme. High-frequency power was to be led to a large antenna consisting of an elevated metal area connected by a vertical wire to a large metal plate buried in the earth. The receiving antenna was to be equal in every respect. The figure in the *Journal of the Franklin Institute* shows the source of oscillations connected into the vertical wire near the earth at the sending station, and the receiving apparatus in the corresponding place at the receiving station. He did not patent the antenna. Tesla states his belief that the electrical oscillations will be propagated along the surface of the earth and that they may be assisted by an upper conducting layer of the atmosphere—this is eight years before Heaviside and Kennelly. Tesla had thus supplied, two years before wireless began its commercial career, all the elements of both spark and continuous wave sending stations. For the receiving station the Lodge or Branly coherer was already available for spark telegraphy, but Tesla concentrated on continuous waves because he was more interested in the transmission of power than in the transmission of messages. After building one or two small stations, he started in 1897, at his own expense, a station of 200 kilowatts in Colorado. From this point in 1899 he transmitted power enough to light a lamp at 30 km. For the reception of continuous wave signals he invented the interrupter device known as a ticker, which was employed by others for the next dozen years, and from the Colorado station received signals at a distance of 1,000 km. Later, his form of antenna, his rotating discharger, and his tuned transformer were used successfully by many others at spark stations in every country.

Space limits this survey to a few of the new things which Tesla's creative imagination and constructive genius gave to the world. His other inventions include pyro-magnetic generators, thermo-magnetic motors, unipolar dynamos, meters, lamps, mechanical vibrators of huge power and a variety of instruments. Some seven hundred patents stand in his name, mostly taken out before he was fifty years of age. Apparently his method of work was to state a problem, devise solutions, build machines and file a patent specification or, possibly, read a paper to a technical society. Then he would start on a new problem. It happened that one of his subjects, high-frequency discharge, made a brilliant display, and he was persuaded to lecture upon it several times. The demonstrations were perfect and very showy; consequently sober folk concluded that Tesla was somewhat of a showman. This is quite wrong. Throughout his long life of eighty-five years, Tesla seldom directed attention to his own successes, never wrote up again his old work, and rarely claimed priority though continually pirated. Such reserve is especially striking in a mind so rich in creative thought, so competent in practical achievement.

W. H. ECCLES.

Dr. A. L. Lowell

OF the two late presidents of Harvard, Eliot and Lowell, it was said that Eliot found Harvard a college and built upon it a university, while Lowell found a university and unearthed its college. Eliot developed great post-graduate schools, from medicine to business administration; but his free elective system for undergraduates left the college almost spineless. It was for his successor to revalue the meaning of a B.A. degree, and he did.

The chief monument of Lowell will be his scheme of concentration (reading one main subject) and his general examination (final schools). Anglophile in nothing so much as in education, he had always approved of this method, nearly identical with that of Oxford and Cambridge, but had to watch the previous regime spare the rod and spoil the undergraduate. In the last decade of Eliot's reign, most pupils used to scoff at honours; in the last decade of Lowell's, the tendency was to scoff at those unequal to reading for them.

The second great change under Lowell was likewise of British pattern. He broke up an unwieldy university into colleges, again like Oxford and Cambridge. Long a cherished plan of his, he lacked funds for it, until one day about fifteen years ago a stranger called at the President's office. Lowell, in the midst of a busy morning, almost did not see the caller—a certain Mr. Harkness. "If," said the stranger, "you suddenly had a lot of money given you—let us say millions—for the university, what would you like to do with it ?" Lowell actually produced a set of blue-prints from a drawer. "Build separate colleges," said he promptly. "Exactly my idea," responded Harkness. "Yale, where I come from, has declined such a gift. Will you take it, and how much do you need ?" The result was the seven 'Harvard Houses' —built either entirely new or to include conversion of several hostels already in use—at the cost of 3½ millions sterling. (Yale then changed its mind, whereupon Harkness cheerfully donated enough more to Yale for a similar project. It was Harkness funds, of course, which also came later to Great Britain for the Commonwealth Fellowships and for the Pilgrim Trust.)

The third milestone in the presidency of Lowell was once more inspired by the example of England. He founded in Harvard the Society of Fellows, an adaptation of All Souls, Oxford. Under this foundation—the funds said to have been given by Lowell, himself a wealthy man—a committee of senior fellows, members of staff in Harvard, elect each year eight junior fellows, graduates of any American university of standing, for postgraduate research. These fellowships yield enough to cover all expenses of the holder, and are renewable (from three to six years) until his specific problem of research is completed. He has the utmost freedom, being not required to work for a degree. Junior fellows live in the various 'Houses', and in time may be offered appointments to the staff.

As the most important personality in American education in his time, Lowell exerted a national influence. So appreciative of his leadership were benefactors, whether old Harvard men or not, that during his own tenure of office—twenty-four years—he saw the endowment of his University tripled; when he retired in 1933 it stood at some thirty millions sterling. A dozen books which Lowell wrote will ensure him remembrance as an authority on government—government in America, in Great Britain, and on the Continent; but his annual reports, as president, to the Overseers of Harvard, are essays in the advance of education, not at Harvard only, but also throughout America.

Lowell died on January 6 at the age of eighty-six.

WILLARD CONNELY.

NEWS and VIEWS

British Association

Conference on Science and the Citizen

THE British Association, through its Division for the Social and International Relations of Science, is arranging a conference on Science and the Citizen: the Public Understanding of Science, to be held on Saturday and Sunday, March 20 and 21, at the Royal Institution, Albemarle Street, London, W.1, by kind permission of the Managers. The Conference will be opened by Sir Richard Gregory, president of the Association, and there will be four sessions, the subjects of which will be the exposition of science, radio and cinema, science as a humanity, and science and the Press. The chair will be taken, at the successive sessions, by Sir Henry Dale, president of the Royal Society and director of the Royal Institution, Sir Allan Powell, chairman of the governors of the B.B.C., Prof. J. L. Myres, and Sir Richard Gregory. It is hoped that an exhibition of films of scientific interest will follow the session on radio and cinema. A list of speakers and other particulars will be issued in due course, and these and tickets of admission will be obtainable from the British Association, Burlington House, London, W.1. The Association, in arranging this conference, is continuing its policy of dealing, by this and other methods, with subjects of especial importance in relation to post-war reconstruction, which were touched upon in the course of the conference on "Science and World Order" held in September, 1941.

Dr. Godfrey Rotter, C.B., C.B.E.

DR. GODFREY ROTTER has recently retired from the post of director of explosives research, Woolwich, after about forty years in Government service. Having graduated from the University College of North Wales, Bangor, he entered the then Experimental Establishment of the War Office in 1903; for the last twenty-one years he has been the head of the Directorate of Explosives Research. Before the War of 1914–18 he had proved his capacity for design, and he received an award for his part in the design of the 106 Fuze, of which nearly a hundred million were made. As a chemist, he showed his skill in devising apparatus for the study of the properties of explosives, of which that for the determination of their sensitiveness is the standard instrument to-day. During 1914–18 he took his full part in the invention and development of new high explosives and propellants, so that when Sir Robert Robertson left in 1921 he succeeded him as director. Of his achievements during the last twenty years it is impossible at this time to speak, but it may be said that he has been associated with notable advances. Of an engaging disposition, and giving an example of an extraordinary capacity for hard work, in an endeavour to keep abreast of ever-increasing activities, he retained the affection and respect of all his staff. He is succeeded by Prof. S. Sugden, of University College, London, who was a member of the Department during the War of 1914–18.

Prof. S. Sugden, F.R.S.

PROF. SAMUEL SUGDEN, who has been appoin superintendent of explosives research, Royal Arsenal, Woolwich, for the duration of the War, has been since 1937 university professor of chemistry, University College, London. Prof. Sugden's massive achievements in research cover a wide field. His native inspiration led to the discovery of a property related to the molecular volume and known as Sugden's parachor. This inspired chemical investigations all over the world, and supplied much valuable information regarding the constitution of chemical compounds and the nature of valency linkages. In his book "The Parachor and Valency", published in 1929, he gave a masterly account of the subject. He has made notable contributions to magnetochemistry. For example, when Pauling concluded from wave mechanics that bivalent nickel, palladium and platinum, unlike the non-transitional elements, can form 4-covalent compounds of plane type which can further be distinguished by their smaller paramagnetic moments, Sugden supplied the first experimental evidence to support this view. It is significant of his keen interest in this field of investigation that he has selected magnetochemistry as the subject for the ninth Liversidge Lecture which the Chemical Society has invited him to deliver. Further evidence of the great fertility of Sugden's researches is found in his investigations on dipole moments, induced radioactivity and the rare earths. He was elected a fellow of the Royal Society in 1934. His powers as a thinker and investigator allied with a flair for exposition have earned him distinction as a scientific writer and teacher.

Institution of Electrical Engineers Awards

THE council of the Institution of Electrical Engineers has elected the Right Hon. Lord Hankey to be an honorary member of the Institution. This distinction has been conferred upon Lord Hankey in appreciation of the valuable services rendered by him as chairman of the Scientific and Engineering Advisory Committees of the War Cabinet, and more recently as chairman of the Technical Personnel Committee. In the latter capacity he has dealt with many problems which have arisen in meeting the demand for engineering personnel for the Forces, the supply establishments and for industry, and has been instrumental in establishing special schemes, notably the intensive training scheme, State bursaries and the engineering cadet scheme, for the training of engineers to meet the needs for future personnel.

The Faraday Medal of the Institution has been awarded to Sir Archibald Page, honorary member and past president of the Institution, in recognition of the outstanding services rendered by him in the sphere of electricity supply, and especially for the prominent part he has taken in the planning, construction and operation of the national grid system in Great Britain, the establishment of which has proved of such inestimable value in the prosecution of the war effort. The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution.

Chemists in Great Britain

A MEMORANDUM to which are attached the signatures of many of the leading chemists, pure and applied, of Great Britain, has recently been circulated.

It is addressed, by members of bodies concerned with the interests of chemists and chemistry, to fellow-chemists, and it asks for increased collaboration between the respective bodies in the form of a federal body "to administer and guide, in accordance with the clearly-expressed will of its members, all the main activities that concern chemists as professional men and working scientists". Whatever the body created for such a purpose, its chief functions would be related to: (1) publications for the exchange and dissemination of chemical knowledge; (2) scientific meetings for the discussion of problems under investigation and for the survey of specific fields of knowledge; (3) libraries, both central and regional; (4) qualification, directed to the maintenance of a high standard of professional competence and of such methods of registration as the profession may decide, whether this registration have *de jure* or only *de facto* recognition by Government; (5) publicity, to ensure that the general public be accurately informed of what chemists and chemistry are doing and could do for the benefit of the community; (6) social security, whereby the economic position and the legal interests of all chemists may be safeguarded; (7) social functions.

A common secretariat, a central house, and close co-operation in all centres between bodies representing chemists are believed to be necessary for the discharge of such functions. As a first step in this direction, the councils of the Chemical Society, the Society of Chemical Industry and the Institute of Chemistry are asked to consider and report immediately on how to expedite the action advocated and to obtain advice as to whether the agreement constituting the Chemical Council can be amended so as to enable the Council to function as a central organization such as that envisaged. Should it be found that the Chemical Council cannot undertake the new functions suggested, it is asked that a new federal body be set up at once, to enable chemists to take their proper part in planning and building the post-war world.

The First Man-Carrying Aeroplane

The Smithsonian Institution, Washington, has recently issued a pamphlet which settles a controversy that has existed for many years. It is universally acknowledged that the Wright brothers were the first to make sustained flights in a heavier-than-air machine at Kitty Hawk, North Carolina, on December 17, 1903. Earlier in the same year a machine built by Samuel Pierpont Langley was reported to have flown, and this was exhibited in the Smithsonian Museum with the label that this "Was the first man-carrying aeroplane in the history of the world capable of sustained free flight". These reported flights had never been officially observed, and in the light of later aerodynamic knowledge it was debatable whether the machine could have accomplished sustained flight under its own power. In order to settle this matter, the Institution reconditioned the machine in 1914, when it was flown successfully, but the fairness of the test was challenged on the grounds that vital alterations were introduced during this rebuilding, which improved its aerodynamic and structural characteristics sufficiently to allow it to be capable of flight. It was claimed that without these changes, based on knowledge that was not available in 1903, the machine could not have flown. These claims have since been upheld by experts, and the Smithsonian Institution has now issued a statement on the results to Dr. Orville Wright and changed the wording of the label on the Langley machine accordingly. Although the detailed explanation has only just been issued, the description on the exhibit was altered in 1928. As a result of this misrepresentation, the Wrights lent their original machine to the Science Museum at South Kensington, where it has been exhibited for many years. The Smithsonian Institution has expressed a hope that Dr. Wright will now consider bringing it back to the United States, where it will be given "the highest place of honour in the United States National Museum".

Meteors Seen in the United States

J. Hugh Pruett has written an account of a detonating meteor (Ast. Soc. Pacific, Leaf. No. 165, Nov. 1942) under the title, "The Portland Meteor and Resulting Meteorite". The meteor was seen soon after 8 a.m. on July 2, 1939, and was not only a conspicuous fireball, but was also responsible for a panic among many people in Portland, Oregon, owing to the jarring of the houses while it passed over the town. From data supplied by a number of observers, it was found that the fireball became visible near the northern Oregon coast-line, and passing over northern Portland, disappeared beyond Bonneville at a height of 10 miles. It was moving in a direction opposite to that of the earth in its orbit and for this reason had a fairly high velocity—probably 40 miles a second. Next day a portion of the fireball was picked up on a farm near Washougal, fifteen miles east of Portland, and it was found that it belonged to the type of stony meteorites known as Howardites. Although search parties were organized, no other pieces were found; but it is fairly certain that the Washougal portion, weighing 225 gm., is not the only fragment which reached the earth. Howardites are described as friable and easily destroyed because the material composing them is cemented together rather loosely.

Another meteor is described by Oscar E. Monning in *Sky and Telescope* (November 1942). It appeared on August 7, 1942, at 9.30 c.w.t., when it was still twilight in the more western regions of its flight, and its magnitude was estimated to be —4. When first seen it was some miles north of Shreveport, and its height then was about 80 miles. In 30 sec. it had moved to a point less than 20 miles north and east of Guymon. Its length of flight may have been 600 miles and its motion was nearly horizontal, as its total drop was about 65 miles during this long flight. It had a long tail and left an evanescent train which was 30° in length as seen from some places, but it persisted for only 5–10 sec. No fragments of the meteor have been found and there were no detonations, so far as present evidence is available, but it is possible that additional information will be obtained which may assist in elucidating further important facts about this bright meteor.

New Projector for Navigational Stars

James R. Benford has given a description of a Bausch and Lomb artificial star projector recently installed at the United States Air Station, Pensacola, Fla., which overcomes many of the difficulties of star charts (*Sky and Telescope*, November 1942). The instrument is located in the centre of a hemispherical dome upon which it projects images corresponding to 145 navigational stars. The instructor and the students sit inside the dome at a level a little below that of the star projector, which makes the stars appear in the darkened room as points of light in a twilight sky. As the projector rotates on its axis once in 20 minutes, the stars swing slowly across the face of the dome in this time, and students are able to gain true impressions of the form, location, and interrelations of the constellations much more clearly than they can from star charts. The apparatus supplies the nearest approach to the actual study of the heavens from outdoor instruction. The latter is not always a satisfactory method when large groups of students have to be considered, and in addition, weather conditions and the season of the year are disturbing factors. The star projector is a most important adjunct to-day in pilot training when speed is so essential.

Effects of Altitude

According to the *Journal of the American Medical Association* of October 24 a law was recently passed by the Senate of Argentina for the creation of a committee to supervise studies on the effects of altitude. The committee, which will consist of medical men, chemists, physicists and biologists, will form a branch of the Ministry of Internal Affairs. The field covered by the committee will be (1) biological problems in relation to the most adaptable human biotypes; (2) working capacity, feeding, housing and climatological, hydrological, geological, zoological, botanical and physiochemical factors in relation to the life of normal men in various altitudes; (3) pathology of altitudes, studies of diseases which may be improved by hypsotherapy, and the establishment of sanatoria and hospitals and proper altitudes for the cure of certain diseases; (4) creation of portable laboratories and establishment of experimental hypsological centres; and (5) studies of the animals and plants of different regions, the constitution of the soil and meteorological phenomena.

Folk-Lore of Children's Diseases

At a meeting of the Folk-Lore Society on January 20, Dr. J. D. Rolleston read a paper on the folk-lore of children's diseases. The field is extensive, since it covers the popular conceptions of the acute exanthemata and other infectious diseases, especially whooping cough and diphtheria, venereal infections, cardiac, respiratory, alimentary disorders and isolated diseases, especially enuresis, infantile convulsions, rickets, hernia and the supposed effects of the 'evil eye'. As regards causation, belief in the doctrine of maternal impressions is still far from extinct, although there is no scientific foundation for such a view. The recognition of astrology by orthodox medical practitioners survived until the eighteenth century, as was shown by Mead's work. The visitation of the 'evil eye' also accounted in popular estimation for many diseases, especially in countries bordering on the Mediterranean. Although a vast number of more or less irrational and inexplicable beliefs were connected with the newborn period, comparatively few of them were of medical interest. Dentition, like menstruation and pregnancy, is a normal process, and was much less frequently the cause of disease than was popularly supposed, especially by mothers who were liable to regard any of their infants' ailments as due to this cause. In like manner, tongue-tie, though often alleged by a mother to account for her child's inability to take the breast, was usually non-existent. The belief in the superstition that venereal disease could be cured by transfer to healthy young virgins of either sex was still prevalent, and was one of the chief causes of acquired syphilis or gonorrhœa in children. Although in other departments of medical folk-lore, especially dermatology, ophthalmology and otology, prophylaxis has received much less attention from the folk than curative treatment, in the case of children's diseases, much more importance seems to have been given to prevention than in other branches of folk-medicine. Examples of the kind were the use of salt for guarding the newborn against evil demons and evil influences, the use of amulets and the administration of coral in the mother's milk.

Infant Mortality in the United States

In a recent article on infant mortality in rural and urban areas in the United States (*Public Health Rep.*, 57, 1494; 1942), Herbert J. Sommers, of the United States Public Health Service, states that the infant mortality-rate in the registration areas of the United States has been reduced by more than a half. From 1915 until 1929 the urban rate, though higher than the rural in every year, decreased more rapidly than the rural, so that in 1929, for the first time on record, the rate was lower in urban than in rural areas, and since then the urban rate has remained lower than the rural. The rates were generally higher in the south than in other regions and rural rates were generally highest in the Middle West. The reduction in infant mortality which has taken place in cities is to be attributed to increasing emphasis being laid on the principles of sanitation, the establishment of 'well-baby' clinics, the increasing use of hospitals for delivery, the compulsory pasteurization of milk and the application of modern medical knowledge.

Physical Education

In a lecture delivered before the Anglo-Swedish Society and published in the December issue of the *Anglo-Swedish Review* on the development of physical education in Great Britain and the Dominions, Miss P. Spafford, organizing secretary of the Ling Physical Education Association, said that organized physical education in Great Britain and the Dominions originated in the elementary schools, while the educational, medical and recreative gymnastics were based on Per Henrik Ling's principles. In newly built schools throughout the country conditions for physical education are excellent. Many have their own swimming bath as well as a field for games and a gymnasium. The physical education scheme in schools in Canada, South Africa, Australia and New Zealand is largely that carried out in British schools. The War has inevitably caused a certain set-back in physical education owing mainly to a shortage of gymnastics and game schooling as well as a lack of gymnastics equipment. The most popular physical activity in all the countries of the British Commonwealth is swimming. Physical training in the Services is based on the Swedish and Danish systems and is closely linked up with recent research in physiology and psychology. Until recently there has been little or no organized physical training in the universities, although there has always been sport of various forms. There is a real need for further instructional co-operation, and further research is essential, especially into the physiological basis of exercises.

Medico-Dental History of Cloves

The issues of *Dental Items of Interest* for June–October 1942 contain an interesting and scholarly article on this subject by Dr. Eugene J. Molnar, research associate of the Northwestern University Dental School, Toledo, Ohio. Originally, cloves were first used in the East Indies, India and China. After the decline of the Roman Empire the medical use of cloves was introduced into Byzantium, probably owing to its proximity to the East. The practice of using cloves for the treatment of dental caries, which developed in the middle of the sixteenth century, was introduced from extra-dental sources, namely, laymen, amateur botanists, apothecary-grocers and others. Eugenol, which was first extracted from oil of cloves by Ettling in 1834, received its name from Cahours in 1858, and is widely used in dentistry for the relief of pain. Its exact pharmacological properties for the treatment of caries and odontalgia have received considerable attention, but have not yet been fully determined. The action of eugenol in zinc-oxide-rosin cements, which form the best temporary filling material, also remains unknown.

Larch and Scots Pine Poles

Results of tests carried out on British-grown poles suitable for transmission lines have been reported (*Electrician*, Jan. 22). The tests were made to measure the deflexion of the poles, rigidly supported at 5 ft. from the butt, for any given loading, up to the ultimate load, applied at 2 ft. from the top of the pole; to obtain a value for their ultimate breaking load, and to calculate the average value of fibre stresses. The poles tested were 36 ft. long by 11½ in. diameter at 5 ft. from the butt, with an average diameter of 8½ in. at the top. An analysis of the test results shows the deflexion for any given loading is much greater for Scots pine than for larch poles. On the other hand, the larch has a much greater ultimate strength, requiring an average load of 4,443 lb. compared with an average of 2,800 lb. for Scots pine. Other things being equal, it is apparent from these tests that, from a strength point of view, larch poles are much better for transmission line supports than Scots pine. The ultimate fibre stress of larch is much greater than that of pine, being of the order of 10,500 lb./sq. in., as against 6,500 lb./sq. in. in the case of pine. The figure for Scots pine is well below the generally accepted figure of 7,800 lb./sq. in. for Baltic fir.

The creosote penetration was found to be much better with Scots pine poles than with the larch. The poles were creosoted six days before the tests were carried out, and from an examination of the cross-sections, it appeared that the penetration in the larch poles varied between ⅜ in. and ⅝ in. with an average of ½ in., and in the Scots pine between 1 in. and 4 in. with an average of 2⅝ in. From the figures obtained it is evident that with the same loading and in order to maintain a given factor of safety, the span-length allowed with Scots pine poles should not exceed 63 per cent of the allowable span-length with larch poles; the ultimate fibre-strength of larch accords closely with the figure of 10,000 lb./sq. in. given in *B.S.* 513–1933; the ultimate fibre-strength of Scots pine is considerably below the value generally assumed for Baltic fir (6,500 lb./sq. in. as compared with 7,800 lb./sq. in.); there does not seem to be any relationship between ultimate load and the moisture content of the pole.

Otto Obermeier (1843–1873)

Dr. Otto Hugo Franz Obermeier, the founder of German parasitology and father of German tropical medicine, was born at Spandau in Prussia on February 12, 1843, the son of a non-commissioned officer. He received his medical education in Berlin where he studied under Du Bois-Reymond, Virchow, Langenbeck and Frerichs and qualified in 1866 with a thesis on Purkinje's fibres. While working in a laboratory at the Charité Hospital in Berlin he discovered in the blood of persons suffering from relapsing fever minute organisms presenting a twisting or rotatory movement. His first publication on the subject appeared on March 1, 1873, in the *Zentralblatt für die medizinische Wissenschaften*, and a few weeks later he gave an account of it at the Berlin Medical Society. His attempt to transfer relapsing fever to laboratory animals by intravenous or subcutaneous injection of blood from relapsing fever patients was unsuccessful. His promising career was cut short by a laboratory infection with cholera, and he died at the early age of thirty on August 20, 1873. The following year, at Cohen's suggestion, the organism which he had discovered was given the name of *Spirochæta obermeieri*.

Earthquakes Registered in Spain

During October 1942, twenty-four earthquakes were registered on the seismograms obtained at the Geophysical Observatory at Toledo. The greatest shock was on October 20 when, from an epicentre calculated to have been some 12,010 km. distant, an earthquake recorded *PPz* at 23h. 41m. 25s. U.T. and attained a maximum ground amplitude at Toledo of 170 μ. The shock finished recording at 01h. 30m. U.T. on October 21. Other strong shocks were on October 9 (max. ampl. 50 μ), October 26 (max. ampl. 27 μ) and October 28 (max. ampl. 2 μ). The earthquake of October 14 which began recording at Toledo with *ePz* at 8h. 26m. 45s. U.T. had an estimated epicentral distance from Toledo of 390 km. The epicentre may have been situated at lat. 38° 50′ N., long. 0° 55′ W., which is nearly 80 km. north-north-west of Alicante, and the focus may have been some 29 km. deep. Microseisms interfered with some of the interpretations during the month, all interpretations being provisional.

Disinfection of Cereal Seed

In reply to a question by Major Thorneycroft in the House of Commons on February 4, as to whether in view of the importance which the Minister of Agriculture and Fisheries attached to the increased production of spring cereals, he would consider making it compulsory on all farmers to disinfect their seed according to the best modern practice, Mr. Hudson said that he is anxious that all oat and barley seed should be dressed this spring with a mercury dressing to prevent disease but he prefers to rely on propaganda and advice rather than compulsion. War agricultural executive committees are carrying out campaigns to this effect.

Errata

In the article "Utilization of Glass", in Nature of February 6, p. 173, it should have been stated that the electrical resistance varies by "at least ten thousand-million-fold", and that plate glass is "rolled continuously eight to nine feet wide".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Synthetic Differential Growth Inhibitor

It has been shown[1,2,3] that malt, ungerminated grain and oranges contain a water-soluble, thermostable substance which permits the free growth of epithelial tissues *in vitro* at concentrations at which it inhibits totally the growth of fibroblasts and other mesenchyme cells. In the present investigation, commercial malt extract has been employed, and the methods of biological assay with fragments of ten-day chick's heart have already been described[2,3]. Vigorous steam distillation of malt extract affords a distillate which contains a variety of substances among which, after suitable treatment, a differential inhibitor can be detected.

This was presumably derived from the original factor by hydrolytic fission, but, as it should be a relatively simple substance, attention was focused on its study as likely to provide a valuable clue. The compound is produced in such small quantity that it has not yet been possible to identify it with certainty; its properties and the analysis of derivatives indicated the probability that it is an unsaturated lactone, $C_6H_8O_2$.

A natural product of this composition and character is the so-called parasorbic acid (δ-$\Delta^{\alpha\beta}$-hexenolactone) which occurs in the berries of the mountain ash[4]; this dextro-rotatory substance has not yet been synthesized so far as we are aware. We have obtained *dl*-δ-$\Delta^{\alpha\beta}$-hexenolactone in small yield by condensation of acetaldol with malonic acid in pyridine solution (b.p. 116°/16 mm. Found: C, 64·6; H, 7·3. $C_6H_8O_2$ requires C, 64·3; H, 7·1 per cent); sorbic acid is the main product[5]. Benzoylation of aldol in pyridine solution followed by condensation with malonic acid afforded a solid mixture of acids, and from these by steam distillation and gradual addition of sodium hydroxide a mixture of δ-hexenolactone and benzaldehyde was obtained (Found after removal of benzaldehyde: C, 64·7; H, 6·8 per cent). δ-Hexenolactone exhibits the usual properties of an unsaturated substance and slowly develops acidity in cold aqueous solutions as the result of hydrolysis; it is unstable, becoming orange-coloured in air and light, and it displays a marked tendency to polymerize both as a lactone and as a derivative of an $\alpha\beta$-unsaturated acid. It readily forms a complex condensation product with 2 : 4-dinitrophenylhydrazine ($3 : 2 - 3H_2O$). It is completely removed from aqueous solution by charcoal, possibly in the form of a polymeride. In all these properties it resembles the lactone present in the malt extract steam-distillate.

Synthetic δ-hexenolactone exhibits the differential growth-inhibitory property: the two analysed specimens were active at a concentration of 0·011 mgm./c.c.; a specimen made by the first method and not distilled (avoidance of toxic decomposition products) was active at 0·006 mgm./c.c. A rough quantitative comparison with the malt distillate factor shows, however, that the latter is the more active. Three possibilities therefore arise: (*a*) that the malt distillate factor is optically active δ-hexenolactone, (*b*) that it is δ-hexenolactone and that other substances are accessory to the effect, or that the synthetic compound contains traces of toxic impurities; or (*c*) that it is another substance closely resembling δ-hexenolactone.

The discovery of the differential growth inhibition produced by δ-hexenolactone suggests that it is able to inhibit a growth factor which is more specifically required by fibroblasts than by epithelial cells, and an obvious provisional hypothesis is that the factor may be pantothenic acid, or an analogous substance. We are engaged in experiments designed to test this theory, the first step being the synthesis of δ-hydroxy-$\Delta^{\alpha\beta}$-hexenoyl-β-alanine.

A few further observations are that δ-valerolactone (dihydro-δ-hexenolactone) is non-toxic in the special sense and non-inhibitory. The malt extract distillate contains a highly toxic substance of salicylic acid type and several aldehydes (for example, acetaldehyde and furaldehyde) which are non-differential inhibitors.

Aldol and acrolein are toxic; crotonaldehyde inhibits all growth at a concentration between $M/3{,}000$ and $M/3{,}600$, whereas propionaldehyde and furaldehyde are much weaker inhibitors, the limiting concentrations lying between $M/150$ and $M/200$.

P. B. Medawar.

Department of Zoology and
Comparative Anatomy,

G. M. Robinson.
R. Robinson.

Dyson Perrins Laboratory,
Oxford.

Jan. 25.

[1] Heaton, *J. Path. Bact.*, **29**, 293 (1926).

[2] Heaton, *J. Path. Bact.*, **32**, 565 (1929).

[3] Medawar, *Quart. J. Exp. Physiol.*, **27**, 147 (1937).

[4] Hofmann, *Annalen*, **110**, 129 (1859); Doebner, *Berichte*, **27**, 345 (1894).

[5] The acid, $C_{12}H_{18}O_5$, described by Riedel (*Annalen*, **361**, 89; 1908) is doubtless a dimeride of δ-hexenolactone + H_2O, that is, *O*-δ-hydroxy-$\Delta^{\alpha\beta}$-hexenoyl-δ-hydroxy-$\Delta^{\alpha\beta}$-hexenoic acid.

The Saponin of Fenugreek Seeds

The presence of a saponin in the seeds of *Trigonella Foenum græcum* (Leguminosæ) was first reported by Wunschendorff[1], who had subjected the defatted seeds to a process of extraction with alcohol. He obtained from the alcoholic extract a gelatinous precipitate which was afterwards dissolved in alcohol and reprecipitated with ether. Wunschendorff described the product so obtained as a white semi-crystalline powder, m.p. 214–215°, which gave a yellow colour test with concentrated sulphuric acid, and a white precipitate with barium hydroxide solution. However, he could not assign a definite formula to the saponin, but showed that it gives by hydrolysis a reducing sugar and water-insoluble sapogenin.

In view of the fact that very little is known of the chemical nature of the sapogenin, we have systematically investigated the seeds, and succeeded in isolating the sapogenin in a pure state. The powdered seeds of Trigonella were defatted by extraction with light petroleum, then extracted three times with alcohol. Concentration of the combined alcoholic extracts yielded a brownish syrup which dissolved freely in water, and the solution exhibited considerable frothing on shaking. A solution of the syrup in water was treated with a saturated solution of barium hydroxide; thus a saponin complex was obtained in the form of an orange amorphous precipitate. Further, the complex was suspended in alcohol and decomposed with carbon dioxide, then the alcoholic solution was concentrated to a faintly coloured syrupy solution. The latter solution was gradually poured into dry acetone; thus a white ashless powder was obtained. It melted between 190° and 200° (decomp.), and characterized by giving a white precipitate with barium hydroxide, a bluish precipitate with Fehling's solution, and a yellow colour with concentrated sulphuric acid. Hydrolysis of the saponin with hydrochloric acid gave a water-insoluble precipitate which crystallized from acetone in the form of a brownish semi-crystalline product. It was further purified by extraction (Soxhlet) with light petroleum, then crystallized from dioxan in white plates, m.p. 184°. The crystalline product gave the colour reactions of sapogenins, and appeared to be a mixture of sapogenins from which a pure compound, m.p. 198°, was isolated and assigned the formula $C_{27}H_{42}O_3$, comprising a free hydroxyl group and two inactive oxygen atoms. There is also evidence that it belongs to the sarsasapogenin group of sapogenins, and identity of its structure is now the subject of a detailed study.

GABRA SOLIMAN.
ZAHIRA MUSTAFA.

Faculty of Science,
Fouad I University,
Abbassia, Cairo.

Sept. 29 (recd. by NATURE, Jan. 27, 1943).

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[1] *J. de Pharm. et. de Chim.*, **20**, 183 (1919).

Dynamics of Real Crystals

In his well-known theory of the specific heat of solids, Einstein made the fundamental assumption that all the atoms in a crystal are capable of vibrating independently of one another with the same frequency. It was not meant as an exact description: the intention was to get a sufficiently good approximation without unessential intricacies. His theory has been recalled here at the outset because we find that his approximation is only an extreme form of the hypothesis to be formulated at the end of this note.

In their theory of the vibrations of solids, Born and Kármán introduced the so-called "cyclic lattice hypothesis", which is the basis of the whole theory of crystal dynamics developed by Born and his collaborators. Sir C. V. Raman has recently questioned the correctness of the hypothesis and has suggested that it is dynamically unsound; it need scarcely be said that if the hypothesis is unjustified from the mathematical point of view it must be given up. Even if the exact theory of the lattice vibrations based on certain extreme idealizations be worked out, it will not serve to describe the vibrations of a real crystal unless it conforms to experiment. The exact and complete solution of the problem of the vibrations of a linear diatomic lattice under internal forces was obtained here some time last year, and has been given independently by Born. Born's work, however, contains some mathematical errors, for his enumeration does not include the obvious translation of the lattice as a whole, or that vibration which, when the number of atoms is only two, corresponds to their mutual vibration.

The cyclic lattice method originally proposed by Born affords the solution that the vibrations take place as those of the infinite lattice the wave-lengths of which are sub-multiples of the dimensions of the finite lattice. In his recent paper he appears to suggest that the cyclic lattice method is justified because the frequency-range given by it is the same as that given by the exact theory. This is not the point of dispute. What had to be shown is that there are vibrations of the finite lattice to which we can ascribe wave-lengths, and that they are of the order $L/N + o(1/N)$.

There are certain features of the cyclic lattice solution which are misleading, such as the degeneracy of over-vibration, and secondly, the existence of progressive wave solutions. It can be shown that over-vibration of a finite lattice is non-degeneracy, and progressive wave solutions are impossible. The exact theory shows that there will be the so-called optical and acoustic branches. However, for displacement (a) of the first atom, the maximum displacement of any atom will be $O(a)$ in acoustical vibrations, while the maximum amplitude will be $O(Na)$ in optical vibrations. The magnitude of the maximum amplitude falls off far more readily in the case of the optical branch than in the other. The important point is that whereas the acoustical vibrations depend on the nature of the boundary, it would require a very perfect crystal with perfect boundary conditions for all the atoms in an optical vibration to vibrate in the same phase, though not with the same amplitude. In the exact solution, infinitesimal displacements in not negligible regions have to form as nodal bridges. These considerations force us to draw a distinction between vibrations in perfect crystals and in real crystals.

The following is a working hypothesis to describe the vibrations taking place in a real crystal:

(1) There will be two types of vibrations, one of high frequency and the other of low frequency. These types must not be confused with the optical and acoustical branches introduced by Born.

(2) Almost all the vibrations will be of the high-frequency type, that is, the number of vibrations will be $O(3N)$.

(3) A high-frequency vibration can appear anywhere in the crystal, being limited only by a closed surface which we term the 'vibrational volume', outside which the disturbance caused will be negligible. The dimensions of the vibrational volume depend only on the nature of the crystal forces and crystalline symmetry, for the high-frequency spectrum will be a monochromatic one with a small number of frequencies.

These assumptions include Einstein's hypothesis in an extreme form when the vibrational volume is the atomic volume itself and over-vibration is a high-frequency one. The ideas contained in (2) and (4) have been stressed by Sir C. V. Raman in his publications.

In contrast with the difficulties of the idealized theories, and the lack of satisfactory correspondence with experimental results, the above hypothesis would seem to account for many of the results, especially the numerous Raman lines in crystals, the infra-red bands, the specific heat and the thermal conductivity of crystals.

Details of this work will appear elsewhere.

N. S. NAGENDRA NATH.

Andhra University,
Guntur.

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[1] *Proc. Roy. Soc.*, A, July 1942.

Density of Frequencies in Lattice Dynamics

THE preceding communication by Dr. Nagendra Nath is one of a series attempting to defend Raman's interpretation of the diffuse spots in X-ray photographs of crystals by discrediting the thermal theory accepted by other investigators of this phenomenon. Raman insists that not only is this application of lattice dynamics to X-ray scattering wrong, but also the foundations of lattice dynamics itself. He questions in particular the method of the 'cyclic boundary conditions', which consists in the following: The vibrations of a finite piece of the crystal depend in principle on the shape of the surface and the dynamical conditions prevailing on it. But if the dimensions of the piece are large compared with the single cell, it is plausible that the dependence on the boundary conditions will be inessential, so that these can be replaced by simpler ones (periodicity). The same assumption is made in the theory of radiant heat (black body radiation) and of the electrons in metals. It has never been doubted in these applications, and whoever rejects it would have to reconstruct these extended theories without this simplification.

In order to disprove Raman's objections directly, I have published the solution of a simple example, the finite diatomic chain (linear lattice), and shown that the quantity essential for the thermal applications, the density of the frequencies, is asymptotically the same for the rigorous and the cyclic solution. Dr. D. E. Rutherford, of the University of St. Andrews, who has checked my results by a different and ingenious method, has found that one of the frequencies given in my paper is incorrect; but this is, of course, quite insignificant for the problem considered, as a linear lattice of 1 cm. length has about 10^8 frequencies. In the preceding communication Dr. Nagendra Nath reports that he has worked out (but apparently not published) the same example and found the same mistake (he claims to have found another one, but this statement of his is incorrect). He has also confirmed the splitting of the frequencies into two branches; whether he has found the asymptotic density law is not evident from his letter, as he speaks only about the 'range of frequency', which is not relevant in this connexion.

Dr. Nagendra Nath's subsequent considerations are incomprehensible to me, as for example: "In the exact solution, infinitesimal displacements in not negligible regions have to form as nodal bridges", from which he infers that one has to consider 'real' instead of 'perfect' crystals. For this purpose he formulates four "working hypotheses" the meaning of which is hard to understand (even if a "monochromatic one [spectrum] with a small number of frequencies" is allowed for as a lapsus linguæ). There seems to be no more justification for these hypotheses in the extensive literature on 'real' crystals than in lattice dynamics.

To end this discussion about the cyclic condition, I have asked the help of a mathematical expert, Dr. W. Ledermann, of the University of St. Andrews. He has proved (see the following letter) a theorem which suffices for the foundation of all purely thermal applications of lattice dynamics (specific heat, thermal expansion, etc.) and in addition shows that a break in the regularity (missing or wrong atoms) at a number of places small compared with the total number of lattice points does not materially influence the thermodynamical results. This theorem may not be quite sufficient for all problems of crystal theory. The scattering of X-rays, however, which is the main object of Raman's attack, is quite independent of it. In a paper which will soon appear in *Proc. Roy. Soc.* I have shown that the formula for the diffuse thermal scattering can be derived in such a way that no other mathematics is used than in the Laue-Bragg theory of ordinary scattering, namely, the fact that certain lattice sums, which are simple generalizations of the Laue function $\sum_{n_1n_2n_3} \exp i(n_1x_1+n_2x_2+n_3x_3)$, are approximately independent of the boundary for large crystals.

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IN connexion with the asymptotic distribution of the eigen-frequencies of a cyclic and a finite lattice, the following mathematical theorem will be found helpful:

Let A be a real symmetric matrix of order n in which we display a 'core' C bordered by a single row and column, thus:

$$A = \begin{bmatrix} C & h \\ h' & \eta \end{bmatrix},$$

where C is a symmetric matrix of order $n-1$, h a column, h' its transpose and η a number. The latent roots of A are n real numbers $\mu_1, \mu_2, \ldots, \mu_n$. Let the number of latent roots which lie in the interval $\alpha \leqslant \mu \leqslant \beta$ be denoted by $P(\alpha,\beta)$. We wish to compare the latent roots of A with those of the matrix

$$B = \begin{bmatrix} C & k \\ k' & \varkappa \end{bmatrix},$$

which differs from A only in the last row and column. If the number of latent roots of B in the same interval be denoted by $Q(\alpha,\beta)$, it can be shown that

$$|P(\alpha,\beta) - Q(\alpha,\beta)| \leqslant 2.$$

This inequality is independent of the particular border (h,η) or $(k,\varkappa)$ and is independent of n. The result is especially interesting for large values of n, as it provides a proof of the plausible fact that the distribution of the latent roots of a *large* symmetric matrix is not materially changed by the modification of the last row and column. When the last p rows and columns are modified, the inequality reads

$$| P(\alpha,\beta) - Q(\alpha,\beta) | \leqslant 2p.$$

Hence if p be small compared with P or Q, it follows that P and Q are asymptotically equal.

The bearing of this theorem on the problem of crystal vibration is as follows: the N atoms of the lattice are divided into internal atoms and boundary atoms, according as the atom has a complete set of *acting* neighbours or not. Instead of numbering the atoms with three indices corresponding to their spatial arrangement (as is usual in lattice theory) we imagine the atoms to be enumerated in a simple sequence, starting somewhere in the interior and taking first all the internal atoms and then adding the boundary atoms. As the vibration is vectorial, there are three equations of motion for each particle. The number, p say, of 'boundary' equations is of smaller order of magnitude than that of the 'internal' equations ($p \sim N^{2/3}$). The matrix whose latent roots are the squares of the frequencies is of the type A considered above, involving a border of p rows and columns. The introduction of the cyclic condition causes a change only in the border elements of the matrix, and the theorem regarding the asymptotic density of the latent roots can be applied; that is, this density is practically the same as that for the cyclic lattice.

The application of the method to the case of defects of the lattice (missing or wrong atoms) is obvious.

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Classification of Rheological Properties

I HAVE been interested by recent reports in NATURE, by the British Rheologists Club, relating to the classification of rheological properties. Since suggestions have been invited for improving the table of deformation, I put forward the following for consideration.

I believe that the table in NATURE of June 20, 1942 (p. 702), already an improved form of the earlier table shown in NATURE of February 14 (p. 197), can be made still clearer if the heading "Flow" is omitted and the first division made a three-fold one into "Elastic", "Plastic", and "Viscous". It may be natural to classify bodies according as they flow or do not flow under stress, but I suggest that this is as arbitrary a classification, scientifically, as some that have been adopted in other parts of the system, its main virtue being that it is based on phenomena readily appreciated by the non-scientific mind.

Further, the groups "Elastic" and "Plastic" overlap at the lower end of the table, and the groups "Elastic" and "Viscous" also overlap, whereas "Plastic" and "Viscous" remain distinct, although these actually have a common heading in the present table. This seems to me a little illogical.

If this step is allowed, then by setting out the three main headings with "Elastic" placed centrally, we can construct the table with less interference of the lines, and keep the three main groups separated. The balance of the table is also preserved. The accompanying diagram shows the arrangement that I propose.

I do not, of course, claim that I am making any addition to the system of rheological classification, but I think that it will be agreed that the proposed rearrangement has some points in its favour.

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Dec. 31.

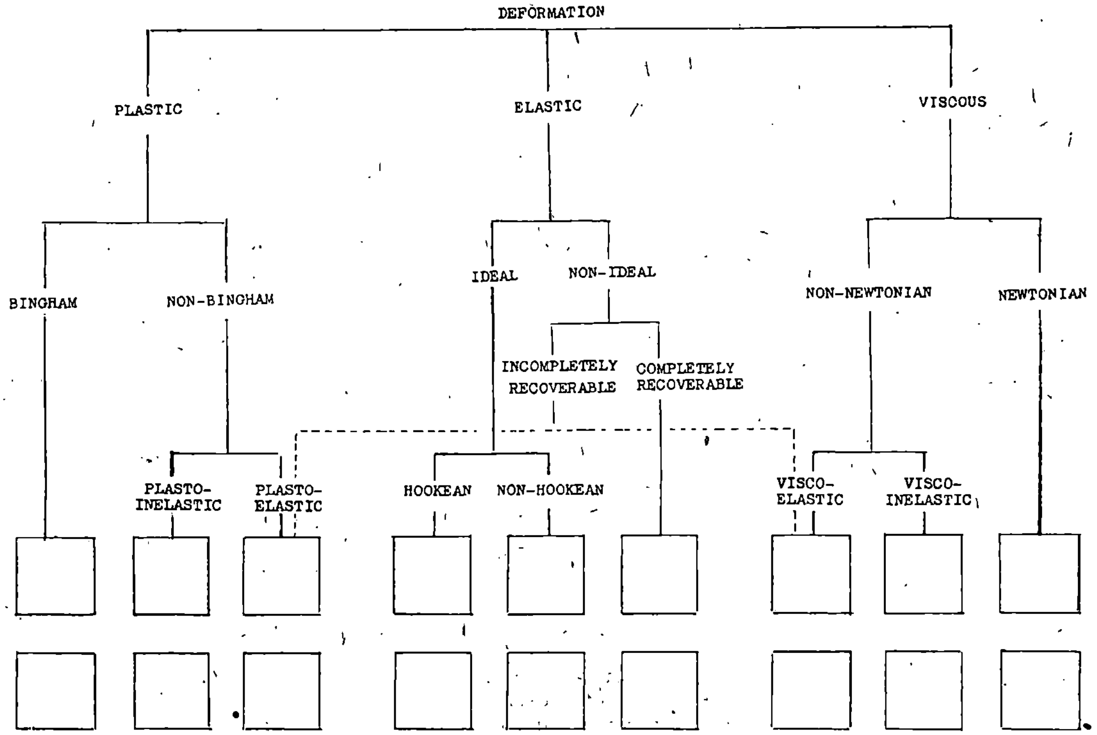
Detection of Acid or Basic Substances in Damaged Fabrics

Feigl and Da Silva[1] have put forward methods for detecting basic and acid substances when present in many materials normally regarded as insoluble, when acidity or basicity cannot be detected in the normal manner, for example, by a pH determination.

We wish to direct attention to a possible use of these methods in the examination of faults in textile materials. It has long been known that acid or basic substances often damage textile fibres, but whereas certain methods of detection are available, there is plenty of room for a quick and reliable method. Feigl and Da Silva's work seems to make this possible.

If a solution of a nickel salt is incompletely precipitated with dimethyl glyoxime and filtered, one obtains a solution which on application to a fabric damaged by alkali (for example, caustic soda) causes the damaged fibres to take on a pink colour which is easily visible. This test has been tried with cotton and woollen fabrics.

Similarly, a saturated solution of silver chromate in ammonia ($6N$), when applied to fabrics damaged by acids, shows a dark red-brown colour. This test did not work so well with damage by hydrochloric



acid on cotton; wool damaged by this acid gives a white spot inside a dark ring.

With coloured materials, while the coloured precipitate is not so noticeable to the naked eye, we have found it easily visible under the microscope even when the fabric and precipitate are the same colour.

Further investigations are in progress with the view of extending the scope of these tests.

C. WHITWORTH.
D. W. POXON.

Loughborough College,
Loughborough.
Jan. 14.

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[1] *J. Ind. Eng. Chem.*, Analyt. Ed., **14**, 317 (1942), and **14**, 519 (1942).

Soil Conditions Affecting Production of Perithecia in Banana Leaf Spot Disease

RECENT research[1] has brought to light the existence of the ascigerous stage (*Mycosphærella musicola*) of the fungus *Cercospora musæ*, during studies on the etiology of leaf spot or 'Sigatoka' disease of bananas. Perithecial formation is mainly seasonal, being greatest between August and January.

Experiments have shown that three-weekly spraying cycles, for example, with 4-4-40 Bordeaux mixture, are unable to control banana leaf spot satisfactorily unless the disease is brought under control before the start of the ascospore season. This applies to almost the whole of the banana-growing districts in Jamaica.

In a few isolated areas, however, it has been found that perithecia are produced in profusion throughout the year. A recent survey of these areas has shown that this 'out-of-season' production of perithecia is positively correlated with the growth of banana plants on highly acid soils (pH 4·0–4·75 approximately). Regular three-weekly spraying has likewise failed to give satisfactory control of the disease at any time throughout the year. Only by employing the weekly heart-leaf spraying method[2] has control been obtained. This method is impracticable once the plants have grown tall; unless liming or some other means can be found to ameliorate the effect of high soil acidity on the metabolism of the Gros Michel banana and its parasite (*M. musicola*), spraying will prove useless as an economic measure of controlling this leaf spot disease under these conditions.

No experimental data are at present available to explain this physiological problem. It is possible that the water relationship of the soil may also be found to play a part in this abnormal production of perithecia. A search through available literature has failed to disclose a similar example of soil conditions affecting the fructifications of a leaf spot fungus.

R. LEACH.

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Jamaica.

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[1] Leach, R., *Trop. Agric.*, **18**, 91 (1941).

[2] Leach, R., "Banana Leaf Spot—When to Spray and Why". (Dept. of Agriculture, Jamaica, 1942.)

Rumford's Contributions to Nutrition

THE instructive note on Charles Darwin's health by Sir Buckston Browne in NATURE of January 2, p. 14, lends interest and certainly gives point to the forthright opinions expressed by Count Rumford about ". . . that most pernicious wash, *tea*, with which . . . the inhabitants of this island drench their stomachs, and ruin their constitutions".

"When tea is mixed with a sufficient quantity of sugar and good cream," he wrote; "when it is taken with a large quantity of bread and butter, or with toast and boiled eggs; and, above all, *when it is not drunk too hot*, it is certainly less unwholesome; but a simple infusion of this drug, drunk boiling hot, . . . is certainly a poison which, though it is sometimes slow in its operation, never fails to produce very fatal effects, even in the strongest constitution, where the free use of it is continued for a considerable length of time."

When, some years ago[1], attention was invited to Rumford's contribution to the science of nutrition, the substitution of potatoes for bread had not the importance which it has now and which it had in Rumford's day. Rumford gives many interesting recipes and records that so strong was the aversion of the (Bavarian) public to potatoes that for a time he found it necessary to disguise them by boiling them down entirely to destroy their form and texture and so prevent them being detected. This is how he made *calecannon*, an Irish dish: potatoes 19 cwt., greens 295½ lb., butter 98 lb., onions 14 lb., salt 40 lb., black pepper 1 lb., ginger ½ lb. 273 gallons of pump water were brought to the boil; the greens were added, and fifteen minutes after they had come to the boil they were taken out and replaced by the potatoes, which were cooked in the same way. The potatoes being mashed (without peeling them), and the greens chopped fine with a sharp shovel, they were mixed together. The other ingredients were added, the whole was well mixed and it was served in wooden noggins to 927 persons. It would be scarcely possible, Rumford remarks, to invent a more nourishing or more palatable kind of food than calecannon; and with this kind of food there is no allowance of bread, nor is any necessary.

Rumford's advice on how to dress salt-fish to perfection has likewise an added interest at the present time: "the secret of cooking it is to keep it a great many hours in water that is *just scalding hot*, but which is never made actually to boil".

A. F. DUFTON.

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Hunton Bridge, Hertfordshire.

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[1] Dufton, A. F., *The Lancet*, **231**, (5913), 1535 (1936).

Sir Henry Miers

EXCEPT in popular estimation, no man's reputation really rests upon a single discovery, and whether Ramsay or Rayleigh discovered argon, or whether Ramsay, Hillebrand or Miers discovered helium, are really questions involving the definition of the word 'discovered', and, as Mr. Humberstone has found[1], of little or no interest to those most particularly concerned.

However, the circumstances surrounding those discoveries are of real interest, and may be made living stories through the correspondence which passed between those who participated in them. I have in safe keeping the letters which passed between Ramsay and Miers and a mass of papers and correspondence belonging to Ramsay, which were left by Lady Ramsay. I hope to publish them after the War.

MORRIS W. TRAVERS.

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[1] NATURE, **151**, 111 (1943).

FORMATION OF PLANETARY SYSTEMS

A CONSIDERABLE amount of interest has been shown in recent times on the subject of the origin of planets and satellites, and various theories have been developed with the primary object of circumventing the angular momentum difficulty. A recent paper by B. M. Peek, entitled "The Formation of Planetary Systems" (*J. Brit. Astro. Assoc.*, **53**, 1; December, 1942), puts forward a theory which possesses at least the merits of simplicity. He starts off with a quotation from Sir James Jeans's "Astronomy and Cosmogony" (1928), which attempts to explain the angular momentum of the nebulæ: "Any currents or motion in the original medium would contribute angular momentum to the nascent nebulæ, and as these shrank to nebular dimensions, the constancy of angular momentum would result in fairly rapid rotations of the shrunken masses". Peek extends this view to the next order of condensation—the stars—and is thus able to explain how the necessary angular momentum of the solar system, and other possible planetary systems too, can be accounted for.

Starting with a portion of the galaxy having a nearly uniform distribution of matter, Peek postulates the beginning of the gravitational instability which produces *stars*, and further postulates that the random currents in the medium contribute angular momentum to these nascent *stars*. After a time any diffuse star rotating about an axis which is perpendicular to its equatorial or invariable plane will have most of its angular momentum concentrated close to the rim of this plane. The system has no resemblance to Laplace's nebula, which was supposed to rotate almost like a rigid body. For this reason the main bulk of the star will be almost spherical, not lenticular, as contraction proceeds. In time, however, the small portion of matter at the rim, which received its momentum from the original current, will have communicated some of its motion to other portions in the immediate vicinity, owing to viscosity. The shrinking of the star is necessarily accompanied by an increased angular velocity, in order that the angular momentum may be preserved, and finally portions of matter will be expelled from the periphery and will describe orbits about the still shrinking star. Some quantitative results are given, among which reference may be made to one in particular. Peek has calculated that if the original current had the same order of mass as all the planets combined and moved with a velocity of two metres per second, this current would have been able to endow the whole of the solar system with its observed angular momentum.

By the time all the matter had been shed, a small fraction of the angular momentum would have been communicated to the condensing nucleus, and this may be the explanation of the rotation of the sun in a plane which does not differ very much from the invariable plane. It is suggested that after the main nebula collapsed into discrete condensations, stray wisps of the material composing the nebula, possessing random velocities, would hang about in conditions of unstable equilibrium between the stars in process of formation, and would finally be captured by one or the other of these. Here is a tentative explanation of the origin of the long-period comets. The theory is also able to explain the origin of the satellites and especially their direct motion, but it is admitted that retrograde satellites and also a system like that of Uranus present difficulties. Periodic comets may have been formed from matter left over from the planetary condensations.

No detailed explanation is attempted regarding the manner in which matter would be shed from the contracting mass, though certain possibilities are suggested. This particular part of the subject involves very abstruse mathematics dealing with gas-kinetics, and it is to be hoped that this branch will be developed further. It is conceivable that the theory may encounter some of its greatest difficulties here.

HEALTH IN INDUSTRY

THE importance of securing, in the crisis of man-power and woman-power through which Great Britain is now passing, that there is no waste of labour and that the full woman-power and man-power of the country is utilized to the maximum extent possible in furtherance of the nation's war effort—though it should be noted that the latter is not to be interpreted too narrowly—is now generally appreciated. As the last report of the Chief Inspector of Factories showed, the importance of eliminating the loss of man-hours and woman-hours due to accidents and to sickness is still far from being realized. Nor, as that report and successive reports of the Select Committee on National Expenditure have indicated, have managements either in industry or in Government departments and factories learnt the lessons and applied to good purpose the experience acquired during the War of 1914–18.

That truth is well emphasized in the third report of the 1942–43 session from the Select Committee on National Expenditure. Here the results of the investigations of the Committee on the health and welfare of women in war factories are detailed, and the observation recorded at the outset that little attention seems to have been paid to many of the constructive suggestions contained in earlier reports on health and welfare problems would justify this further inquiry. The relation of health to production is indeed one of the widest interest, as well as of growing importance as the demands of the War grow more imperative. It involves the co-operation of the worker as well as of factory management and of the Government.

Broadly speaking, an efficient general state of health in industry depends on the improvement and maintenance of what is commonly called physical fitness; the prevention of diseases and of accidents; the treatment of sick and injured persons and their rehabilitation to fit them for return to industry. The problem to-day is largely one of the most economical use of women, particularly in view of the breakdown of any system of medical examination as to the fitness of women for factory work before they are transferred to work away from home.

The results of this inquiry are set forth in three main divisions: health and welfare within the factory, and, secondly, outside the factory; and the State and industrial health. In regard to the first, matters relating to the maintenance of health can be grouped under three general headings: (*a*) physical amenities, such as the provision of satisfactory canteens, cloak-rooms, rest-rooms, etc.; (*b*) medical provisions, such as first-aid, preventive measures for specific industrial diseases, and the general medical supervision of the life of the factory; and (c) general oversight, such as the administrative and executive action which has to be undertaken by welfare or personnel officers. While the general level of physical amenities is on the whole satisfactory and in many factories the standard reached is high, the Committee raises a number of matters in relation to canteens, including inadequate time for meals, and to cleanliness and rest-rooms, which should be brought to notice.

It is recommended next that the Government should give the closest attention to the problem of securing a satisfactory industrial medical service, at least within all the factories engaged on Government work. In this connexion the Committee considers that greater use could be made of women medical practitioners and recommends further that consideration should be given to the question of establishing a centralized employment register for trained nurses. Once again the recommendations that further energetic measures to improve the general standard of lighting in the medium-sized and small factories should be taken by the Ministry of Labour and the supply departments concerned, and that the provision of adequate ventilation in royal ordnance filling factories should be dealt with as a matter of urgency indicate how far we are even yet from harnessing to the service of our war effort even existing scientific knowledge.

Other recommendations in this field are that the supply departments should assist contracting firms to introduce black-out arrangements that will allow of the entrance of a reasonable amount of daylight to workshops, canteens and rest-rooms, and that when new Government factories are in course of construction, or are to be built in the future, expert advice and co-operation should be sought at the earliest stage to ensure that adequate systems of lighting and ventilation are adopted. Further evidence confirms the comments of the Chief Inspector of Factories as to the frequent neglect to take the elementary precaution of training new workers in the use of safety devices, and in regard to hours of work further research and experiment are recommended to determine the best method of arranging a rotation of shifts in royal ordnance factories so as to reduce fatigue and to ensure a minimum of inconvenience to workers and managements. The Committee suggests further that, where a two-shift week is worked, it would be advantageous for departments to organize a five-day week for their women employees.

Once again the crucial importance of personnel management is stressed. The Appointments Board of the Ministry of Labour should carefully consider whether more use could not be made of older men and women with a good educational background as labour officers in factories, and the Select Committee recommends further that the Ministry of Aircraft Production should co-operate with the Ministry of Labour in organizing courses for training personnel managers and welfare workers for firms in the aircraft industry, to which the existing staff in aircraft firms might be sent for refresher courses. It is somewhat disturbing to find that there is still neglect of personnel organization in the aircraft industry, and the Committee also comments on some lack of co-operation between the production staff, labour management and the medical officers in the royal ordnance factories. Examination by the Ministry of Labour of the existing machinery for transferring workers from one district to another with the view of securing a closer relation between regions that are exporting labour and those that are receiving it, so as to ensure that factories are notified of the arrival of new workers in sufficient time to enable the necessary arrangements to be made for their reception, is also recommended, as well as a review of the subject of wartime nurseries.

The latter question falls into the section of the report dealing with health and welfare outside the factory. Here stress is laid on shopping difficulties, which are still acute for most women-workers in many areas, and on the provision of billets, to which a like remark applies. Here the Committee suggests that the regional and local welfare officers of the Ministry of Labour might impress on the more backward firms the advantage to be gained by making better provision for the welfare of workers outside the factory, such as the development of social centres or clubs, and the installation of shower-baths for those unable to obtain baths.

The section of the report which deals with the State and industrial health is of major interest to scientific workers. Discussing first the allocation of responsibilities, the Committee agrees with the broad division of functions between the Ministry of Labour and the supply departments, which should carry a joint responsibility for the maintenance of good personnel management. It is recommended that the factory inspectorate should be relieved of any tasks that can be transferred elsewhere without loss of efficiency, so that the inspectorate may be free to concentrate on the maintenance of good standards of safety and health. It is pointed out, however, that co-operation between the inspectorate and those responsible for the royal ordnance factories has not been as full as it might be. The constitutional relationship is not altogether easy, and the medical branch of the factory inspectorate from its composition has neither a staff sufficient to provide advice and instruction on a wide scale nor the authority to ensure that the advice it is able to proffer is accepted by those who need it most. Again, while the Ministry of Labour's welfare officers have done much useful work in securing the provision of facilities for the health and welfare of workers outside the factory, difficulty has been experienced in obtaining suitable people for this advisory work by local recruitment, and the Select Committee recommends that the Ministry of Labour should take immediate steps to recruit older women with the right type of experience.

Neither the Ministry of Supply nor the Ministry of Aircraft Production has, in the Committee's opinion, given the attention to the problems of industrial health and welfare in contractor's factories that is desirable, and the Committee recommends the appointment of medical women as additional advisers to both Ministries. The report once again notes the failure of the supply departments to utilize fully the special knowledge of the Industrial Health Research Board, and while expressing the hope that the fullest use will be made of the results of the work now being undertaken, stresses the need also for comprehensive planning.

To meet this need and to place the existing organization for creating and maintaining the standards of industrial health on a surer foundation, the report finally recommends a rearrangement of the medical supervision of industrial health. First, the medical branch of the factory inspectorate should be enlarged and strengthened. Secondly, a central industrial health advisory committee should be set up forthwith to advise the Ministry of Labour and the supply departments on all questions of industrial health and on the co-ordination of medical services to meet the requirements of the war effort. Regional industrial health advisory committees should also be set up to advise the Ministry of Labour, the regional boards and employers on the co-ordination and extension of industrial health centres in each region. A central bureau should be established for collecting, abstracting and disseminating information and literature relating to all questions of industrial medicine. The need for this is particularly stressed, including the publication of a bulletin, and the bureau might be modelled on similar organizations existing in other fields of applied science. Working in close association with the British Medical Association, the Medical Research Council (particularly the Industrial Health Research Board), and the Association of Industrial Medical Officers, and with an enlarged and strengthened organization of medical inspectors of factories, these committees should do much to reduce the incidence both of industrial disease and of general sickness among industrial workers and others, and thus materially increase the volume of output with a corresponding reduction in cost to the nation.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, February 13

Iron and Steel Institute (joint meeting with the Sheffield Metallurgical Association, the Sheffield Society of Engineers and Metallurgists, and the South Yorkshire Section of the Institute of Chemistry) (at the Royal Victoria Station Hotel, Sheffield), at 2.30 p.m.—Mr. H. T. Shirley and Mr. E. Elliott: "A Critical Consideration of some Applications of the Spectrograph to Steelworks Analysis".

North-East Coast Institution of Engineers and Shipbuilders (at Bolbec Hall, Newcastle-upon-Tyne), at 6 p.m.—Dr. W. D. Jones: "Powder Metallurgy, its Products and their Various Applications".

Association of Scientific Workers (Harpenden Branch) (at the Congregational Hall, Harpenden, Herts.), at 5 p.m.—Mr. F. Le Gros Clark: "Agriculture in relation to Food Policy".

Monday, February 15

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8 p.m.—Dr. Kaare Rodahl: "The Swedish-Norwegian Expedition to North-East Greenland, 1939–1940".

Tuesday, February 16

Royal Society of Arts (Dominions and Colonies Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. S. S. Pickles: "Rubber, Natural versus Synthetic".

Society of Chemical Industry (joint meeting of the Agriculture Group and the London Section) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. G. W. Robinson: "Methods and Interpretation of Soil Analysis".

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir Lawrence Bragg, F.R.S.: "The Solid State" (iv) "Plus-plus Compounds".*

Institution of Electrical Engineers (Wireless Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Electronics in Industry" (to be opened by Mr. E. Cattanes, Mr. G. T. Winch and Mr. A. L. Whiteley).

Wednesday, February 17

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. C. H. Desch, F.R.S.: "Magnesium" (Peter le Neve Foster Lecture).

Royal Meteorological Society (at 47 Cromwell Road, South Kensington, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1941 to November 1942".

Institute of Physics (at the Royal Institution, Albemarle Street, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting. Dr. J. R. Baker: "Freedom in Science".

Thursday, February 18

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. J. M. Gulland: "Aspects of Nucleotide Chemistry" (Tilden Lecture).

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Charter Centenary Meeting and Address by the President, Mr. W. Spencer Howells.

Friday, February 19

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. E. J. Salisbury, F.R.S.: "The Flora of Bombed Areas".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Annual General Meeting. Mr. K. S. Laurie: "Some Textile Finishing Machines".

APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Teacher of Mathematics and Science at the East Ham Technica College—The Secretary for Education, Education Office, Town Hal Annexe, Barking Road, East Ham, London, E.6 (February 19).

Laboratory Steward in the Department of Physiology—Th Secretary and Registrar, The University, Bristol (February 20).

Psychologist for the Derby Child Guidance Clinic—The Actin Director of Education, Becket Street, Derby (February 22).

Two Senior Technical Assistants—The Executive Officer, Eas Riding of Yorkshire War Agricultural Executive Committee, St Mary's Manor, Beverley, Yorks. (February 22).

Director of the Gas Research Board of the Gas Industry—The Secretary, Gas Research Board, Gas Industry House, 1 Grosveno Place, London, S.W.1 (February 22).

Lecturer in Mechanical Engineering, and an Assistan Lecturer in Mechanical Engineering—The Registrar, College o Technology, Manchester 1 (March 1).

Master to teach Mathematics and Science at the Bingle Technical School—The Divisional Educational Officer, Educatio Offices, Bingley, Yorks. (March 7).

Chair of Chemistry in the University College of North Wales—The Bursar and Acting Registrar, University College of North Wales Bangor (April 3).

Assistant Lecturer, mainly for Science, Mathematics an Drawing—The Principal, County Technical School, Halesowen Worcs.

Teacher of Engineering Workshop Practice and Genera Engineering Subjects at the Burton-on-Trent Technical Institut and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-on-Trent.

Speech Therapist—The Education Officer, County Hall, Wakefield

Part-time Demonstrator in the Physics Department—Prof H. Dingle, Imperial College of Science and Technology, South Kensington, London, S.W.7.

Laboratory Assistant for School Laboratory—The Senio Science Master, The Science Schools, Harrow School, Harrow, Middx

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Post-War Planning and Reconstruction. Pp. 48. (London: Institution of Municipal and County Engineers.) 1*s*. [15

Other Countries

Commonwealth of Australia: Council for Scientific and Industria Research. Pamphlet No. 113: Drainage Investigations in the Horticultural Soils of the Murray Valley. By A. L. Tisdall. Pp. 23+1 plate Pamphlet No. 115: Studies on the Shrinkproofing of Wool, 1: Th Industrial Development of the Freney-Lipson Process of Holeproo Ltd., Melbourne; 2: Further Studies on the Prevention of Shrinka in Wool Goods, by M. Lipson and Carmel J. Clyne; 3: Experimenta Work on the Treatment of Wool by the Woolindras Process, by D. R Zeidler. Pp. 33. (Melbourne: Government Printer.) [7

Public Library of South Australia. First Report of the Librarie Board of South Australia, January to June, 1940, with the Annua Report, July, 1940, to June, 1941. Pp. 8. (Adelaide: Governmen Printer.) [7

Forest Research Institute, Dehra Dun. Indian Forest Leafle No. 21: How to Identify Timbers, Part 1: Hints on the Identification of Indian Timbers. By K. Ahmad Chowdhury. Pp. ii+5+2 plates 4 annas; 6*d*. Indian Forest Leaflet No. 24: Plywood Containers By Sultan Mohammad. Pp. ii+5+2 plates. 4 annas; 6*d*. India Forest Leaflet No. 25: How to Identify Timbers, Part 2: Timbe for Helves and Tool Handles. By K. Ahmad Chowdhury. Pp. 6–16 4 annas; 6*d*. (Dehra Dun: Forest Research Institute.) [8

Indian Lac Research Institute. Bulletin No. 46: Physical Chemistr of Resin Solutions, Part 4: The Relationship between Solvent-Powe Gelation Capacity and Viscosity of Shellac Solutions in Mixed Solvent By Dr. Santi Ranjam Palit. Pp. 14. 1 anna. Bulletin No. 48 Physical Chemistry of Resin Solutions, Part 5: The Solvent-Solut Relationship of Resins in Mixed Solvents. By Dr. Santi Ranjam Palit Pp. 12. 4 annas. Technical Note No. 7: A Simple Method of Preparin Pure Resin from Shellac. By Dr. Santi Ranjam Palit. Pp. 5. (Namkum: Indian Lac Research Institute.) [8

Society of Biological Chemists, India. Annual Review of Biochemical and Allied Research in India. Vol. 12 for 1941. Pp. iii+ 84+xix. (Bangalore: Society of Biological Chemists.) 3 rupees 6*s*. [8

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SCIENTIFIC RESEARCH AND DEVELOPMENT

Research in War-time

THE satisfaction which was felt at the time when the Government announced on September 4 the appointment of three scientific advisers to the Ministry of Production, to complete the organization for scientific research and development, has been somewhat diminished by subsequent changes in the Government itself. The appointments did not, it is true, meet all the criticism that had been advanced of the organization of the scientific resources of Great Britain in furtherance of the war effort, and in particular the demand for the establishment of a whole-time Central Scientific and Technical Board. Further, it was recognized that the success of the new arrangements, including the appointment of Sir Charles Darwin as scientific adviser to the Army Council, depended largely on the right men being chosen to fill the new posts, as well as on the spirit in which the Ministries and Departments would co-operate, as was pointed out by the Select Committee on National Expenditure. None the less, there was a general feeling that the new organization should be given a fair trial before criticizing it too severely.

One of the reasons for welcoming the appointment of the three full-time scientific advisers to the Minister of Production was the statement that they would work under the immediate supervision of the Lord Privy Seal (then Sir Stafford Cripps), acting on behalf of the Minister. With Sir Stafford's appointment as Minister of Aircraft Production, he has now to carry the responsibilities of the administration of a department of crucial importance, and he has also been invested with special responsibilities in regard to the anti-U-boat campaign which must make further large demands on his time. Not only is it therefore unlikely that he will be able to devote the detailed attention to the activities of the new scientific advisers which was expected, but also, since he is no longer a member of the War Cabinet, he can scarcely represent their views to those who are directing the War, at any rate so effectively as scientific workers expected in welcoming the appointments.

For these reasons Sir Stafford Cripps's paper on "Government and Science in Great Britain" at the opening session of the recent conference of the Association of Scientific Workers on "Planning of Science: in War and in Peace" (see NATURE, February 6, p. 152) was awaited with unusual interest. Sir Stafford Cripps's statement, however, proved somewhat disappointing and in general added little to the statements which we have already had on various occasions from Lord Hankey and Lord Chatfield, with which it can fairly be compared. At many levels there is, as Sir Stafford Cripps was able to show, close collaboration, but he admitted that in regard to industrial research there is still room for better integration of research and development with the supply ministries.

Sir Stafford Cripps's statement does suggest, indeed, that we are much nearer securing that the immediate study of strategy and tactics by the General Staff is conducted with an awareness of the possibilities which technical and scientific advance has put in our hands. Nothing in his address, however, goes far to resolve the doubts as to whether we can safely rely on advisory bodies for this purpose, or whether it is necessary that there should be some Central Scientific and Technical Board with executive, rather than advisory, powers. The failure to realize sufficiently early the vital part which science would play in this War, to which Sir Stafford Cripps alluded, is indeed an important consideration which might favour an executive body. Moreover, it has to be remembered that the time factor, which Sir Stafford gives as one reason for not creating a "tidy plan" of scientific organization of the war effort, may be an equally decisive reason in favour of a central scientific body with executive rather than advisory powers. Only so may it be possible on occasion to cut out departmental delays and bring down the interval between discovery and production to months or even weeks, as against the normal lag of years in peacetime.

The proposals advanced by Mr. E. D. Swann on behalf of the executive of the Association of Scientific Workers at the conference stress this vital factor of time and the importance of ensuring that the limited resources of Great Britain are fully used on the most vital problems. They provide for the establishment of a Central Scientific and Technical Board with scientific and technical qualifications and wide executive powers. This Board would be in direct contact with the War Cabinet, which it would advise on scientific matters. It would relate the country's scientific effort to the strategy determined by the War Cabinet.

It cannot be said that Sir Stafford Cripps, any more than Mr. Lyttelton, has shown that such central direction is unnecessary. Admittedly we are still paying the price for our long-continued national neglect of science, with the result that throughout the Fighting Services and in the Civil Service there are far too few in positions of high responsibility competent to assess the scientific and technical factors involved in the day-to-day tactical and strategical problems of the War. Scientific workers are not, of course, in supporting such proposals, advancing the claim to determine policy, though the extent to which policy must be based on scientific and technical considerations tends to increase rather than otherwise. It is, however, their moral responsibility to see to it by all means in their power that those responsible for the formulation of policy give full weight to the scientific and technical factors involved. More they cannot ask ; and to ask for less is a dereliction of duty.

On the whole, it may well be held that the balance of evidence points to some Board possessing executive authority, such as that suggested by the Association, the Parliamentary and Scientific Committee and other bodies, to supplement the work already being done by the Scientific Advisory Committee, the scientific advisers to the Minister of Production, the Engineering Advisory Committee and the numerous other committees, to the activities of which Si Stafford Cripps referred. At the same time it shoul be recognized that the personnel of such a board apart from its status, may well present greate difficulties than at first appear, and that much spad work will be required to ensure that it can functio harmoniously and effectively in its numerous depart mental relations.

There are two further points, however, whic should be noted. In the first place, while Air Chie Marshal Sir Philip Joubert de la Ferte's polite version of the dicta that the expert should be kep on tap, not on top, cannot be gainsaid, there is thi much to be observed. Sir Philip rightly said tha from the military point of view the ideal is for th Services to state the need and to put the requirement to the scientific man for investigation, but that at n time should the latter exercise judgment over militar matters. The real point at issue is this ability of th Fighting Services to formulate their requirements i time, simply because that can now only be done wit difficulty, or not at all, by those without sufficien first-hand knowledge of science to be aware at leas to some extent of the general trend of scientifi advance and its technical possibilities. Without tha background, the right questions and problems ma not be put to the scientific worker, or, if put, ma be put too late. It seems clear that Sir Philip Jouber himself appreciates this weakness, for he admitte that the division of functions is not always clear cut and that scientific men might be required to elucidat the position by advising on the need itself, as well a the requirements.

The second point relates to British contact wit the United States, to which Sir Alfred Egerton' address was devoted. It cannot well be maintaine that there is even yet a properly organized centr agency for bringing together the work of all th missions to the United States. Even if it possesse no executive authority, a Central Technical an Scientific Board should be able to establish a centr information bureau from which scientific and technical liaison could be conducted, so as to ensure tha departmental missions are at least in touch with on another, and that those at the centre know what al and not just a few, of the departments are doing.

The three charts reproduced on pp. 206–207, whic are based on diagrams prepared for the Conferenc illustrate the war-time organization of scientific effo in Great Britain, the United States and the U.S.S.

Research in Peace-time

This Conference of the Association of Scientif Workers, however, was summoned to consider th planning of science in peace as well as in war. S Stafford Cripps did well to remind us that there is i reality no difference in the principles that should b applied in time of war and in time of peace. It shoul also be remembered, however, that to ensure th speedy winning of the war, it may be necessary t adopt measures, in view of our long neglect of scienc as a nation, which should have no place in the pe manent organization when the appropriate steps t repair that neglect have been taken and had effect. The question whether the present organization and utilization of science in Great Britain are adequate to the service of national needs should not be determined solely by reference to war-time conditions. The principles on which that organization is based should be scrutinized in relation to long-term needs and tendencies, and not merely the pragmatism of war.

There is no need here to open a fresh discussion as to whether or not science should be planned. We cannot escape the necessity of planning, broadly, our scientific activities, along with other activities, if we are to ensure a society in which orderly development is possible and the opportunities which scientific advance has given us are to be enjoyed by the many and not by the few. It is not a question of planning or of not planning, but of the extent to which we shall plan, and the limits which are placed on our planning by the necessity for preserving a free society and the freedom of investigation and utterance essential to scientific advance. It is a question of so ordering society as to secure the best conditions for encouraging the highest quality of scientific and of other creative work.

Once this is clearly recognized, the controversy between the planners and those who oppose all planning as inconsistent with the freedom of science is seen to be irrelevant. Freedom for scientific inquiry, as Prof. H. Levy remarked, may be a catchphrase that confuses the issue and may obstruct advance, even if it does not play into the hands of reactionary movements. Freedom comes by recognizing and overcoming restrictions, not by ignoring them, and scientific workers may well ponder carefully a suggestive passage in Prof. E. H. Barker's great book, "Reflections on Government", in which he discusses, first, the process of democracy itself as an example of the scientific method, and then the authority of natural science and the place of the scientific expert.

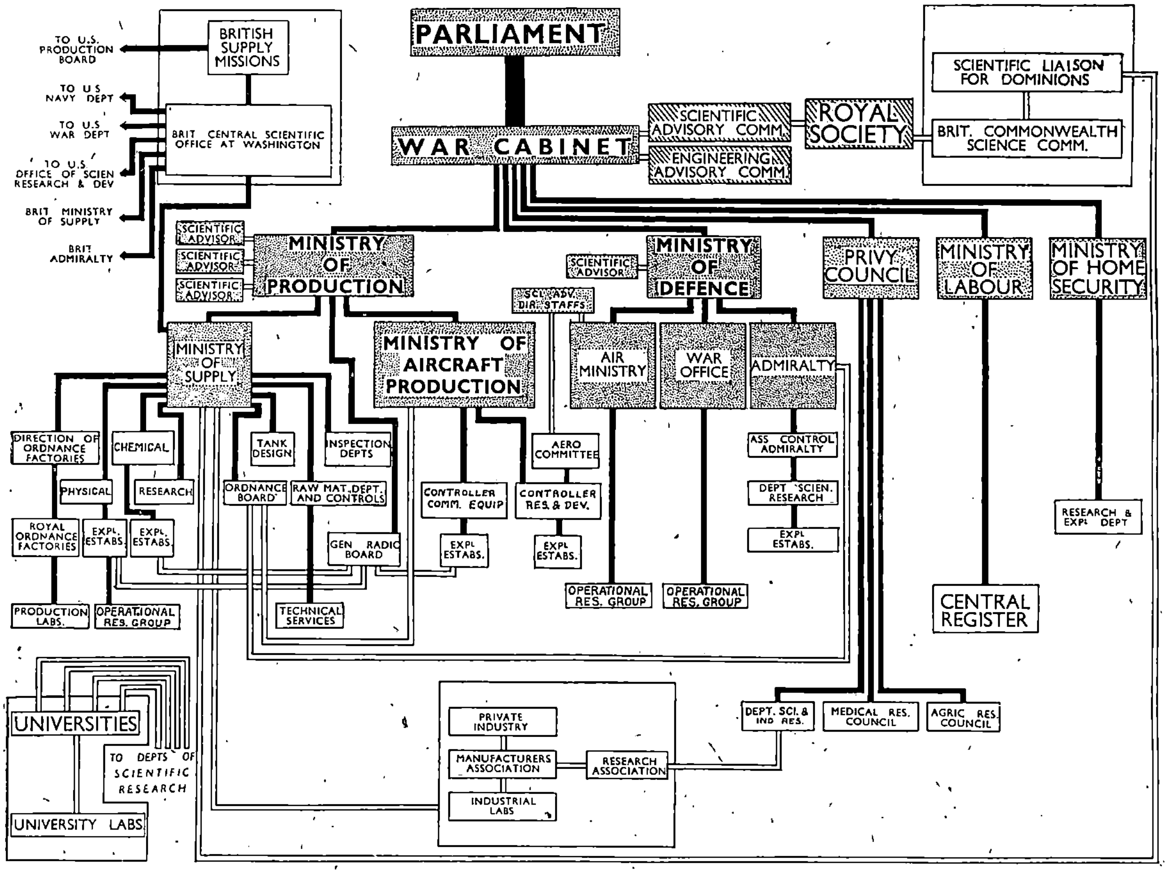
The effective prosecution of any adequate reconstruction policy will call for a much more effective utilization of science than in the past, but this emphatically does not mean the regimentation of science. It must involve, however, not simply the allocation of greater resources of material and man-power to scientific and to technical research as well as to training in science, but also to some extent the distribution of those resources where they are most needed in the interests of the community as a whole. It is not only in time of war that advance has been retarded and the solution of problems delayed because of the uneven front of research, and excessive concentration of man-power and resources on particular and even narrow fields. The problem is one of securing a reasonable balance between the different fields of knowledge, not of dictating the problems to which attention shall be given within particular branches of science; effort must be diverted from time to time to fields which from one cause or another appear to have been neglected, whether through special difficulties or the absence of sufficient incentive in comparison with others. It is no interference with the true freedom of science, for example, for the Government, in greatly extending its encouragement and support of long-range or fundamental research at the universities, to which we look for creative discoveries, to ear-mark its endowments for particular broad fields as, for example, agricultural biology, which have been comparatively neglected in contrast with the related field of nutrition. There must be some means of redressing the balance if society is not to suffer continually from the absence of scientific knowledge at some point which has not been sufficiently attractive to engage the attention of individuals.

It is equally true that there must be some satisfactory relation and balance between such academic research at the universities and that proceeding in industry and in Government departments. No policy of expansion of industrial research or research in Government institutions could be fruitful in the long run if long-range and fundamental research in the universities were starved. Further, both industrial research and research by Government departments are required to apply, for the benefit of the community, the advances in knowledge which come from the universities, apart altogether from the contributions in technique and the stimulation to thought which so often results from contact between workers in the universities and in industry or Government departments. An important aspect of the planning of science is indeed to foster such contacts and the frequent exchange of staff as well as of information. There could be no surer way of developing mutual respect between academic and industrial workers and breaking down misunderstanding and ill-feeling.

Some of the problems in this respect are admirably set forth in the paper which Mr. R. S. Bickle contributed to the discussion on planning after the War. The broad problems of scientific personnel were discussed by Sir Lawrence Bragg, who urged the importance of starting now to plan the university courses and facilities for research which would be required and clarifying ideas as to the existing institutions which could be used as nuclei for concrete proposals. In regard to personnel, he believes that the Central Register is the right body to watch conditions and to find the men, and that it will be essential to continue it for some years after the War. If the support and advice of the general body of scientific men be given to it, it would solve many problems of post-war placement, of assessing needs, and of regulating conditions. The problem of making use of scientific assets in planning the reconstruction of Great Britain is, he thinks, one of the most difficult of the post-war problems. It involves bringing home to political leaders and Civil Servants the place of science in the new world, bringing them into personal contact with the great leaders of science and firing their imagination with the possibilities of scientific achievement. Without this process of education, we cannot hope to devise the permanent machinery and organization for ensuring the wisest use of scientific and technical resources and the encouragement of fundamental research over the whole front of science.

How wide is the range of problems was well shown in Prof. P. M. S. Blackett's paper. Besides the re-education of a large number of younger scientific men and the re-building of fundamental research in the universities and research institutes, including the technical re-equipment of university research laboratories, there are such problems as the future scope and status of the expanded Government research establishments, and the encouragement of close relations between such laboratories, industrial research laboratories and the universities, and the place of the scientific societies in this relationship. Then there is the opening up of scientific relations with other countries and the organization of scientific assistance to liberated countries to help them restart their scientific life.

ORGANISATION OF SCIENCE IN THE U.K.

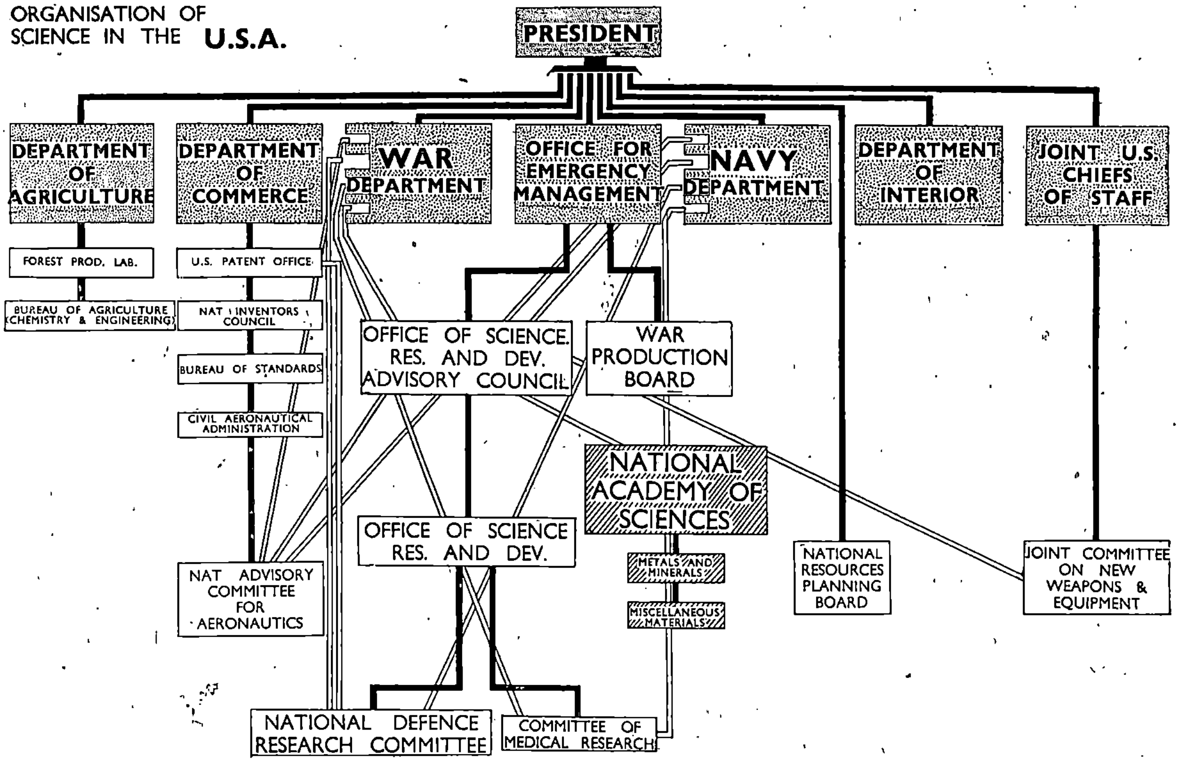


There can be no doubt as to the demands which such problems will make on scientific workers, and the attendance at the conference arranged by the Association of Scientific Workers, was welcome evidence that the younger men of science recognize their responsibility towards society as a whole. The effective utilization of science in the war effort and in reconstruction depends not only on the scientific man himself but also on the co-operation of management and workers as well. There has been persistent criticism of shortcomings in production in the reports of the Select Committee on National Expenditure, the Industrial Health Research Board and the Chief Inspector of Factories, of the failure of management to make full use of scientific knowledge which has long been available, in such matters as welfare, lighting, hours of work, safety and the like. If some of the criticism of management at the conference was beside the mark and showed a sad indifference to the principles of scientific administration, the emphasis on the position of the scientific worker in relation to joint advisory committees was indeed timely. More might well have been heard of the importance of this factor of scientific management.

That indeed is the right way, as Sir Robert Watson Watt pointed out recently, for the scientific worker to demonstrate that he belongs to the Third Estat in a true democracy of production. The scientifi method must pervade all stages of production and c use of the product; and the scientific worker mus live with the maker and the user. He can only appl the tradition and skill of his craft, however, in direc co-operation with his fellow-craftsman, and tha influence will only be exercised when he takes hi place as an essential third party, understanding th points of view of both management and labour bu bringing his own independent contribution.

The Conference on the Planning of Science will hav served its purpose if it stimulates scientific workers both junior and senior, to think afresh about thei place in industry and in society, as well as of th functions and scope of science.

ORGANISATION OF SCIENCE IN THE **U.S.A.**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BUREAU OF AGRICULTURE CHEMISTRY & ENGINEERING
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CIVIL AERONAUTICAL ADMINISTRATION
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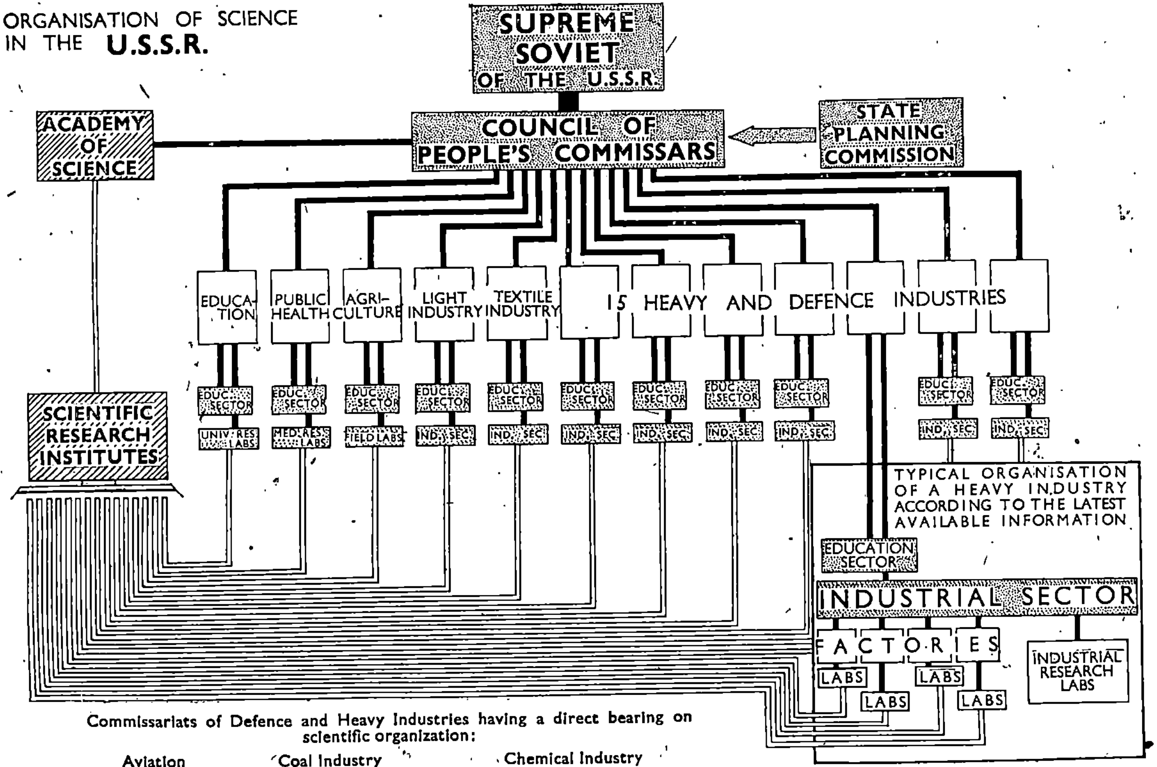
NATIONAL ACADEMY OF SCIENCES
METALS AND MINERALS
MISCELLANEOUS MATERIALS
OFFICE OF SCIENCE RES. AND DEV.
NAT ADVISORY COMMITTEE FOR AERONAUTICS
NATIONAL RESOURCES PLANNING BOARD
JOINT COMMITTEE ON NEW WEAPONS & EQUIPMENT
NATIONAL DEFENCE RESEARCH COMMITTEE
COMMITTEE OF MEDICAL RESEARCH

ORGANISATION OF SCIENCE IN THE **U.S.S.R.**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Chemical Industry
Building Materials
Medium Engineering
General Engineering
Heavy Engineering

MODERN ADVANCES IN TECHNOLOGY

Modern Engineering

By C. H. S. Tupholme. Pp. xi+201+23 plates. (London: Faber and Faber, Ltd., 1942.) 15*s.* net.

IT is one of the disadvantages of war that scientific and technical people are often dispersed far and wide, are unable to meet each other at scientific meetings, and have not, through the technical censorship, access to the latest information respecting new materials and processes. It frequently happens that individuals are simply not aware of the newest developments in science and technology, and this may have an adverse effect on their own work, or delay its successful prosecution. This enforced isolation is mitigated to a large extent by the present text. The author, within the limits tolerated by security, conducts his reader through many technical developments spread over a wide field. Many of these were introduced before the War, but the exigencies of the latter have forced them beyond the experimental stage, until they can no longer be deemed experimental or even developments, but must be included as regular practice in up-to-date manufacture.

The author commences with mechanical power generation from fuels, and shows that appreciable advances in fuel economy must result in the newer types of forced-circulation boilers, mercury boilers, super-charged Diesels, and multiple-fuel engines. Whereas workshop practice was revolutionized by precision grinding, even greater changes have been brought about by automatic oxygen-cutting of forgings to pattern, flame hardening and softening, surface hardening by depositing hard metals, high-speed steel, diamond and cemented carbide tips for super-speed lathe work, the manufacture of gauges and re-surfacing with hard chromium plating, and general restoration of worn parts. While these techniques have improved the product, and lowered the cost by reduction in time of manufacture, many of them would not have been possible without the testing gauges for measuring surface finishes. The piezo effect has been called in to detect the irregularities of a surface in terms of 10^{-6} inch, while the principle of the optical flat, made of quartz, has been applied to the workbench for testing the flatness of a surface by showing the interference bands. Photographing templates on material to be cut and profile projection are becoming routine practice.

For protecting workers and utilizing certain processes requiring absence of dust and a controlled climate, the principle of air-conditioning has been greatly assisted by new safe refrigerants. Air-conditioning in mines, in railway coaches and motor-cars, both for passengers and produce, is becoming common in many parts of the world. Where carbon dioxide is a production by-product it has become a habit to install plant for making 'dry-ice', for which there seems an insatiable demand in many fields. An important production advance has been made by cooling softened duralumin and so delaying the age-hardening, which sets in after two hours, until the material has been worked.

On the chemical side the various plastic materials offer wide scope for designers, and while we are warned by the plastics industry not to be too optimistic about the wholesale replacement of metal parts by plastics, it is obvious that for economy, lightness and conservation of metallic resources, plastics will play a great part in replacing metal objects, and offer new scope in artistic design. New hyper-pressures of 1,000 atmospheres are already in use for ammonia synthesis. Aluminium and magnesium alloys need scarcely be mentioned, apart from the fact that die-cast parts of light-alloy can be designed to require no machine-finishing. A new development is to clad duralumin with pure aluminium, with marked reduction in corrosion, particularly in the hulls of flying-boats. The chrome-nickel stainless steel has the virtue that it is actually toughened by welding, and does not require subsequent annealing, apart from its remarkable retention of strength, impact and anti-corrosion properties at high temperatures. The admixture of lead to steels has vastly diminished the time and cost of machining mass-produced parts. Welding has gone ahead with carburizing techniques, especially valuable for long pipes, while electric valve control has speeded up and made more uniform electric welding. Electro-magnetic and X-ray detection of flaws in metallic bodies has been increasingly used. The development of bright-annealing of metals in controlled atmospheres, especially conditioned town-gas, has many incidental advantages.

On the fabrication side there is the new technique of forming tubes into any contour of section and the electro-deposition of metal inside intricate moulds, such as can be made of rubber or fusible metal. The electrical instruments for precision control, whether of thickness of a continuous product, for limit-gauges or combustion recording, are endless; fluorescent lamps find applications for sterilizing air in schools and factories, detecting manuscript frauds, and for stage and factory lighting. While infra-red lamps have been used for the local baking of coloured car finishes, whole tunnels have been used for processing the complete motor-car. While the advances in traction, marine engineering, and aeronautics make abundant usage during manufacture of all the preceding processes and materials, the last makes several *ad hoc* applications of science, particularly in de-icing, navigation, and blind-flying and landing.

Because the author is discrete in many of his references and also covers so wide a field, he would often appear scrappy to a particular specialist and perhaps obscure to the inquiring layman. The reviewer would normally direct attention to two important fabrication processes which have been omitted; there are in addition a few misprints. Nevertheless, there is a considerable field of usefulness for this type of book at the present time, and, in this type of survey, the author has discharged his task well with regard to prevailing conditions.

L. E. C. HUGHES.

RESEARCHES ON FUNGI

A Revision of Melanconis, Pseudovalsa, Prosthecium and Titania

By Lewis E. Wehmeyer. (University of Michigan Studies, Scientific Series, Vol. 14.) Pp. viii+161+11 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1941.) 14*s.* net.

IN this book Dr. Wehmeyer continues his systematic revision of the stromatic Pyrenomycetes, which commenced with his "The Genus Diaporthe and its Segregates" published in 1933. The species concerned are nearly all found in the bark of broad-leaved trees of the northern hemisphere, and with very few exceptions each is characteristically associated with one genus of host plants.

The perithecia are formed in groups in or below stromata which, unlike those of Diaporthe, are not normally associated with black zones of fungus tissue. The primary characters that have traditionally served for distributing the species into different genera are the colour, the septation and the appendages of the ascospores. Often locules are found within the young stromata, or acervuli on their flanks, and from these are produced conidia of two sorts, the broad so-called alpha- and the narrow beta-conidia. Partly through ignorance of the facts, and partly, despite the facts, out of deference to Saccardo's monumental "Sylloge", the perithecia and the two sorts of conidia of the same species have often enough been studied independently of one another; and so have acquired each their vested interest in the systematist's apprehension, and an independent name in his schizophrenic nomenclature. Thus, for example, the single species *Melanconis thelebola* has been made the type species of the three following genera: *Pseudovalsella* von Höhnel for use when it is found producing its perithecia; *Hendersoniopsis* von Höhnel for use when it is found forming its alpha-conidia, and *Cytosporopsis* von Höhnel for use when it is found forming its beta-conidia.

It is Dr. Wehmeyer's particular mission to join together again what has been so unnaturally put asunder; and this he accomplishes by describing and often figuring each available species in all its known forms. He has included under Melanconis all the relevant species with one-septate ascospores, whether hyaline or dark-coloured, and either with or without appendages; and has grouped them into a number of proposed subgenera. Of these, Eu-melanconsis includes all the species with alpha-conidia one-celled, brown or hyaline, and borne in open acervuli—as, for example, the abundant British *M. stilbosum* on birch. Massariovalsa with similar alpha-conidia which are immersed in locules contains only two species, both of them North American; and Pseudomelanconis contains the species with many septate alpha-conidia of either of the Coryneum (that is, of the dry spored), or of the Steganosporium (that is, of the slimy spored) type. Pseudovalsa is restricted to take three species all with unappendaged several-septate ascospores, and fuscous stromata which bear several-septate alpha-conidia of the Coryneum type on an open hymenium. It includes the abundant British *Pseudovalsa lanciformis* on birch. Prosthecium, as here employed to take seven species, has several-septate appendaged ascospores, and stromata which bear in open or closed locules the several-septate alpha-conidia.

Of the other genera, Titania is known only from the type collection of its type species, *T. vesuvius*; its asci each contain only a single ascospore.

In an appendix, the genus Calospora is revised away on the ground that its first species is a Melanconis; all the species included at various times in the genus have been examined and re-distributed. Thus *Calospora platanoides*, well known in Britain on sycamore, appears earlier in this monograph as *Prosthecium innesii* (Currey) Wehmeyer.

The genera Massaria, Aglaospora, Thyridaria and Pseudotrichia differ from all the foregoing in the presence, between the asci, of numerous filiform persistent paraphyses; the author, however, is not yet satisfied that this character justifies their transfer from the Sphæriaceæ to a separate family, the Pseudosphæriaceæ.

It is a great pleasure to register a further stage of Dr. Wehmeyer's progress through the stromatic Sphæriaceæ. The very difficult group of Didymosporæ are now as good as done; and the Phragmosporæ are more than well begun.

E. W. MASON.

WOUND INFECTIONS

Pathology and Treatment of War Wounds

By Sir Almroth E. Wright. (Researches from the Inoculation Department, St. Mary's Hospital, London, W.2.) Pp. viii+208. (London: William Heinemann (Medical Books), Ltd., 1942.) 21*s*. net.

SIR ALMROTH WRIGHT has collected in this volume the addresses and papers upon wound infection that he published during the War of 1914–18. It is a fitting and salutary memorial of the pioneer work on a subject that was forced into prominence by the unprecedented casualties of that war. It is fitting because we can assess the large proportion of that work which has stood the test of time: and we can admire the brilliance of the experimental and technical devices invented by Sir Almroth and his colleagues, by which they were able to demonstrate the defensive action of leucocytes in open wounds and the connexion between 'corruption' and the loss in the tissue fluid of the power to neutralize the 'tryptic' processes of infection; and by which they defined the conditions in which a merely contaminated wound would flare up into gas gangrene, and measured the efficacy of the available methods of antibacterial treatment. It is salutary for its few examples of how too close an adherence to a technical approach, however fruitful, can be a stumbling block, as in the exploration of acidosis in the wounded subject by titrations in soft glass capillary pipettes.

It is obvious, however, that both the author and his publishers have not chosen a time like this to publish a volume that was only memorial in intention. *Streptococcus pyogenes* and *Staphylococcus aureus* are still bugbears of civil and military wounds, and gas gangrene is still with us. The treatment of infected wounds still presents many unsolved problems, and a great deal that Sir Almroth has taught deserves to be lifted out of the archives and set under the noses of surgeons and pathologists to-day. But as a lesson to a younger generation the collection would have been better for a little editing, if only to remove the occasional repetitions of experiments and text figures; and the force and precision with which the minutiæ of the experiments are displayed sometimes obscure the emphasis of the main argument.

A collection of papers like this needs a summary. Of his views in 1919, the author has presented a masterly exposition in the chapter on the physiology of wounds, which all who are concerned with the treatment of wounds would do well to read. The case for 'physiological' as against 'antiseptic' treatment still stands, but it does not stand quite so firmly. One would have liked an interpretation of these views in the light of our present knowledge, particularly in chemotherapy and antisepsis. Sir Almroth might with some justice reply that our present knowledge is still too chaotic for a synthesis; nevertheless it would have been valuable if he had attempted it.

A. A. MILES.

SENSITOMETRY SINCE HURTER AND DRIFFIELD*

By Dr. S. O. RAWLING

THE best memorial to Hurter and Driffield is the continued application of their teaching by the photographic industry. The basis of photographic sensitometry is a characteristic curve of the material under test, and when we remember that the particular characteristic curve in use to-day is still known as the 'H and D curve', obtained by plotting density against the logarithm of the exposure, we realize the excellence of the work which was done so long ago by those two enthusiastic amateurs. The principle of sensitometry remains what it was when Hurter and Driffield left it. The details have changed; the values of the co-ordinates of the curve have been corrected and brought nearer to standardization; new apparatus has been applied to the work and the results themselves are interpreted in new ways which make it possible to link sensitometry much more closely with practical photography. I propose to sketch in outline some of the ways in which the H and D curve has been pulled into shape in order the better to guide those who use photography and those who must provide the best kind of photographic material for each particular purpose.

It is almost fifty-three years since Hurter and Driffield published what was probably the most important of their papers[1]. This was entitled "Photochemical Investigations and a New Method of Determination of the Sensitiveness of Photographic Plates" (*J. Soc. Chem. Ind.*, May 31, 1890). In this paper they described shortly the "laws of absorption of light by opaque black substances" and defined the meaning which they attached to the terms opacity, transparency and density of a negative. They stated their opinion that "a negative is theoretically perfect when the amount of light transmitted through its various gradations is in inverse ratio to that which the corresponding parts of the original subject sent out". They described a photometer for measuring density and went on to report on the behaviour of photographic plates, using this instrument for measuring the response of the plates to exposure and development. The general shape of characteristic curves was demonstrated, and from this they put forward their doctrine of how to obtain negatives which by their definition should be perfect. Lastly, they described a method of calculating photographic speed values from characteristic curves.

My argument will be found to arrange itself quite naturally about the H and D curve. To begin with the density axis, there came early difficulty. The first note of 'trouble' was sounded in 1891 by Hurter and Driffield themselves in a paper[2] on the "Relation between Negatives and their Positives". Using density values determined on their own photometer, they found that the effects of exposures to light behind the negatives were greater than those calculated directly from the densities as measured. They supposed that this was caused by light reflected from the surface of the printing material, and that part of this light was then reflected back again by the negative on to the printing material. They summarized their observations thus: "The coefficient *a* which converts the density as measured, into the printing density, is, for negatives developed by ferrous oxalate, usually a fraction; for pyro developed negatives it is generally nearly 1, if the negatives be used for contact printing; but when the negative is used for enlarging the factor *a* . . . is always greater than 1, even for negatives developed with ferrous oxalate".

Some values of *a* found for contact printing were 0·8, 0·665, 0·577. The principal cause of the wide disparity between these values of *a* and unity was, however, not 'inter-reflection' of light in the printing process, but the unaccounted loss of light by scatter from the negative in their photometer.

Abney directed their attention to the scattering power of negatives, and tried to show that their photometer might not be giving the true optical density. A lively argument followed, from which Hurter and Driffield emerged at last admitting that "the Captain is not yet satisfied that our photometer gives the true optical density" and adding that "density, however expressed, will need different corrections for different operations". Even in this incident we must admit the prophetic nature of their last remark, which was the expression of a truth not always appreciated at the present time.

Abney was right about the scattering of light. The error caused by inter-reflection was small compared with that caused by scatter. Hurter and Driffield's photometer employed direct beams of light between two lamps and a grease-spot photometer, the negative being inserted in one of the beams. Some of the light transmitted by the negative was scattered out of the direct path and never reached the grease-spot. Thus the instrument recorded density values which were too high.

By integrating the whole of the light transmitted by the negative, density values closely approaching contact printing densities are obtained. In general practice, a sheet of white opal glass in contact with the negative serves very well as an integrator, and most of the densitometers now in use employ this device.

Density measurement has not yet been standardized, though with well-designed contact opal densitometers it is possible to compare results obtained in various laboratories without finding serious discrepancies. The comparison is, of course, limited to contact printing technique, and if negatives are to be used in any other way the original caution of Hurter and Driffield must be taken into account: "density . . . will need different corrections for different operations".

The movement towards standardization of sensitometric technique has been most marked in the establishment of standard light sources for sensitometers. The candle and other flame sources have become obsolete, and in their places are electric lamps run at specified colour temperatures.

The commonly used, substandard, vacuum lamp of the photometry laboratories is capable of working well at a colour temperature of 2,360° on the Kelvin scale of temperature, and it was finally decided that such a lamp should be adopted as part of the standard light source for photography. The choice of 2360° K. appears to have followed from the fact that this was supposed to be the colour temperature of the acetylene flame, which had been used with a correcting filter to imitate sunlight.

The 2360° K. light was, however, not adopted as a complete standard. It was capable of much higher output than the candle and it was relatively richer in blue light, but photographic technicians craved for a more evenly balanced distribution of energy such as occurs in direct sunlight. The improvement demanded was not to be gained without sacrifice. It was necessary to filter out the excess of green and red light. The experience of the standardizing laboratories was used in selecting the suitable filter, and after a considerable amount of argument the choice was made from a large series of filters devised and specified by Davis and Gibson[3], of the American Bureau of Standards. This filter converts light from a colour temperature of 2360° K. to the approximate quality of mean noon sunlight at Washington. Thus we are in possession of the specification of a standard light source which can be realized very easily in the laboratory, which gives a fairly even distribution of energy over most of the visible part of the spectrum, and satisfies those who cry for 'artificial sunlight'. In passing, it may be noted that the extreme variations in the quality of real daylight are probably almost as great as between ordinary electric light and mean noon sunlight. For example, the light from clear blue sky is almost as weak in red as the electric light is weak in blue. Nevertheless, the compromise adopted for laboratory work must be considered as a very reasonable one.

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* Substance of the Hurter and Driffield Memorial Lecture of the Royal Photographic Society, delivered on November 28. The lecture is being published in full in the *Photographic Journal*.

Recently there has been found a need for light sources of very much higher power. The substandard photometric lamps are vacuum lamps and cannot be run at temperatures much above 2360° K., and their total candle-power is in the neighbourhood of 30. The invention of the gas-filled lamp has provided lamps which can be run for long periods at a temperature of about 2850° K. without much change in output. It is quite common to develop several hundred candle-power in a single small lamp of this kind, and there is available another Davis and Gibson filter which converts 2848° K. (say, 2850° K.) to mean noon sunlight. This filter, since it has not such a wide gap of colour temperature to bridge, has a considerably higher transmission; thus the resulting laboratory sample of mean noon sunlight is of far higher available candle-power than that of the 2360° K. source with its appropriate filter.

The establishment of a standard light source has been one of the most valuable results of all the efforts which have been made towards standardization of sensitometric methods. It is, however, far from being the only factor controlling the abscissæ values of the characteristic curve. Exposure, being a product of time and intensity, introduces the question of which of the factors is to be varied in giving the series of test exposures necessary for determining the characteristic curve of the material under test. Hurter and Driffield, probably for convenience, varied time, keeping intensity constant; we now call this a 'time scale' method. They assumed that the results would have been the same if time had been kept constant and the intensity had been varied. But reciprocal variation of time and intensity does not always produce equivalent photographic results. In pictorial photography the varying tones in a given negative are all produced by exposure for the same time (determined by the shutter) to a series of intensities determined by the brightness of the various parts of the image in the camera. It seems, therefore, that the ideal system would be to use an intensity scale in sensitometry. This, however, is easier said than done. On the other hand, time-scale sensitometers are easy to specify and can be constructed with great precision. They have accordingly found great favour in certain applications; for example, they are admirable in providing a scale of exposures for the test negatives employed for checking the performance of developers and developing machines; they are also excellent for checking the uniformity of production of photographic materials. Their main limitation is that they do not give reliable information about the performance of different materials in the camera. The trend has therefore been, in studying the behaviour of different materials in practice, to use so far as possible intensity-scale sensitometers at times of exposure comparable with those employed in the camera.

There are two main difficulties in devising a sensitometer to work on the intensity scale principle. The first of these is the enormous waste of light in providing a wide scale of intensity. The unmodulated light must be of high power in order that the lowest intensity of the scale shall be adequate. It is not uncommon for the last step of a sample exposed in a sensitometer of this type to receive less than one thousandth part of the light received by the first. The second difficulty is that of providing means for varying the intensity over a sufficient range without introducing some change in the quality of the light. The common way of referring to this is to say that it is difficult to make a *neutral* intensity modulator. The common gelatin wedges devised by Goldberg[4] were made of such materials as India ink mixed with bluish dyes to give a reasonable approximation to visual neutrality. They were, however, more heavily absorbing in the blue, violet and near ultra-violet, and more transparent to red and infra-red, than in other regions of the spectrum, and, when employed without proper consideration for this fact, have led to some very misleading conclusions. Other materials, such as highly dispersed graphite and developed emulsion, have been used for casting wedges, but no very satisfactory material for casting really neutral wedges has yet been made available. Stepped wedges can, however, be made by exposing photographic plates in stepwise manner and then developing them. Such wedges are usually sufficiently neutral for ordinary sensitometry.

We have now come to the interpretation of results of sensitometric measurements. Hurter and Driffield considered the photographic speed of a negative material in terms of the minimum exposure necessary to record the deepest black of a scene on the lower extremity of the straight line region of the characteristic curve. It is true that their graphical method of determining speed necessarily implied the inclusion of a little of the foot of the characteristic curve where the slope is changing and is less than that of the straight line, but with the negative materials which they favoured the amount of the foot so included was small, and we must admit that these negatives conformed very closely to *their definition* of a perfect negative if we ignore, as they did, the distortion of tone produced in the image by scattered light within the lens and camera.

One conclusion which has been drawn from the theory of tone reproduction is that, for true tone reproduction *in the print* made from a negative, the product of the slopes of negative curve and positive curve should be unity. Now in making prints on paper it is, more often than not, desirable to use almost the whole tone range of the paper from nearly clear white to a density approaching the maximum black possible. Thus the whole of the characteristic curve of the paper comes into play, and since this curve really is 'curved' and not a straight line for the whole of its course, a complication of the Hurter and Driffield doctrine results. To obtain a perfect print, the angle of slope of each part of the negative curve must be complementary to that of the corresponding part of the paper curve. The highlights of the scene correspond with the darkest part of the negative and with the lightest parts of the print which are recorded on the least sloping part of the characteristic curve of the paper. The negative record of this part of the scene should therefore be on the most steeply sloping parts of the negative curve. At the other end of the brightness scale of the scene the deepest shadows are recorded near the deepest black of the paper where the slope of the paper curve is greatest. This part of the scene will be recorded at a lower density region of the negative curve, and it follows that the slope of this part ought to be lower than of that part of the curve corresponding with the highlights. Thus the negative should include part of what Hurter and Driffield called the under-exposure region of the curve.

The problem is to decide how much of the lower part of the negative curve should be included. As an experimental argument, let us try whether the question may be answered by selecting as a limit that point on the negative curve where the angle of slope is the exact complement of the slope of the paper curve in the region which is to depict the shadows of the scene. With a very large proportion of present-day printing papers, the region of the characteristic curve used for the greater part of the shadows is that of maximum slope ; and this is generally related, roughly at any rate, directly with the contrast-giving power of the paper. By using the 'hardest' printing paper available, it will be possible to creep down a very long way into the foot of the negative curve and still obtain true tone reproduction in the deep shadow regions of the print. Meanwhile, however, what has happened to the remainder of the tone scale ? The choice of the hardest available printing paper will bring with it the difficulty that the whole tone scale of the paper will be brought into action by a very small density range in the negative, and our print, while recording the deepest shadows with accuracy, may exaggerate the middle tone differences and record all the highlights as blank white paper. Thus the limit of our creep down the negative curve in search of speed must be set not only by the conditions necessary for reproducing shadow detail but also by the total density range of the negative. The latter is the main factor which determines the contrast grade of the paper which must be used in printing, a fact very well understood by Hurter and Driffield themselves. The contrast grade of a printing paper may indeed be fairly accurately expressed in terms of the negative density range which it will accommodate[5].

The slope of the curve of the selected printing paper must therefore depend on the density range of the negative from which the print is to be made. The smaller the density range of the negative, the greater must be the slope of the paper curve and vice versa. Our first attempt at deciding how far we may creep into the 'under-exposure' region of the curve has thus failed, unless we first choose a printing paper of the correct exposure range (correct contrast grade) for the negative concerned.

Photographic 'speed' of a negative material thus appears to depend not only on the power to record shadow detail, but also on the density range produced in the negative by the whole scene, that is to say, upon the contrast of the negative as a whole.

As a rule, the main pictorial interest of a photograph does not lie in the extremes of the tone-range but somewhere near the middle, and we are generally satisfied with a print in which extreme shadows are lacking in a little of their detail. That is to say, instead of insisting on perfect tone reproduction in the shadows, we can there accept some compression of the tone-scale, and the product of the slopes of the negative and positive curves can be less than unity.

We must, however, satisfy the general condition that the density-range of the negative and the contrast grade of the paper must be suited to one another. L. A. Jones has, during the past few years, made a thorough investigation of this problem, and has suggested as a criterion of speed for ordinary pictorial negative materials the exposure corresponding with that point on the characteristic curve where the gradient is 0·3 of the average gradient for a negative recording an image brightness-range of 32.

Jones[6] has tested this criterion by a statistical method. He prepared a number of transparencies of landscapes to serve as laboratory originals for his experiments. His use of one of these transparencies will serve to explain his method. A series of negatives having progressive increase of exposure was made upon each of a number of negative materials. From each negative the best possible print was made, using for each the most suitable available grade of printing paper. Thus for each negative a series of prints was obtained. The quality of these prints varied from quite unacceptable through just acceptable to excellent. Jones employed a group of about two hundred observers to answer the question : which, in the series of prints arranged in order of increasing negative exposure, was the first one which could be called excellent ? The majority vote was taken for each series and so the minimum camera exposure necessary to yield *the first excellent print* was established for each negative material. This was eventually done for more than seventy negative materials and for several scenes, and made it possible to establish the relative working speeds of the materials as judged on pictorial results by the average observer. These results were then used as the established yard stick with which sensitometric determinations of speed could be compared.

The comparison between the statistical practical estimate of speed as determined by the selection of the first excellent print and the speed as measured by the fractional gradient method gave a total spread of 0·17 on the logarithmic scale. That is to say, taking the extremes, two films which are really alike in speed would be judged to have speed values not more erroneous than by a factor of antilog 0·17, that is, 1·5, if their speeds were calculated by the sensitometric method. This criterion is still 'under observation' by various standardizing committees.

I began with some discussion about the influence of scattered light upon the value of density. I end by directing attention to the influence of the camera and its lens in scattering light all over the image formed on the negative material. This light is often much stronger than is commonly supposed. It has the effect of distorting the brightness scale of the image in relation to the brightness scale of the scene. It was ignored by Hurter and Driffield, but has been discussed and investigated by various workers, of whom I should mention Goldberg[4] and more recently Jones[7].

This sketch cannot claim to be a full historical record of the progress of sensitometry since 1890, but I believe that it indicates the principal lines of progress, and provides the necessary starting points from which a student may go on to study in greater detail the science of photographic sensitometry.

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OBSERVATIONS ON THE PHYSIOLOGY OF COLOUR VISION

By E. N. WILLMER
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THE recent article by Granit[1] stimulates further thoughts upon the mechanism of colour vision, and his results may perhaps be interpreted in a slightly different manner.

There seems to be little reason to doubt that the appreciation of colour, as distinct from light intensity, must depend upon the presence in the retina of at least two elements of unequal sensitivity to the various wave-lengths of the visible spectrum. Two possibilities are therefore open. The first is that if we assume colour vision to be entirely mediated by cones, and the current views upon the structure and behaviour of the fovea give support to this assumption, we must postulate two or more types of cone or of cone sensitivity and trust that further research may lead to their actual demonstration. As the position stands to-day, apart from the existence of coloured globules in the cones of certain birds and marsupials, and apart from the extraction of a pigment, or pigments, with three distinct absorption bands from the retinæ of certain snakes[2], there is no histological evidence which speaks unequivocally in favour of the presence of different cone types distributed in the retinæ of higher vertebrates or of man in such a way as to be consistent with the facts of colour vision. Theoretical curves, expressing the sensitivity of hypothetical cone types (blue, green and red receptors) to different regions of the spectrum, have been constructed[3], but in order that they should satisfy all the necessary conditions the curves have to be so nearly identical in form and position that it is difficult to believe that any neural mechanism could be so delicately adjusted as to be able to appreciate the subtle differences of cone sensitivity which these curves indicate.

The second possibility is that the elements required for colour vision are those which are known actually to exist in the retina, namely, the rods and the cones. Owing to the peculiar structure of the fovea, which is believed to be rod-free, and to the general, though not universal, absence of Purkinje shift from this area, nearly all theories of colour vision have been based on the first possibility and the alternative hypothesis has received but scant attention. Nevertheless, it has several points in its favour and, since there are certain facts which fit more aptly into such a scheme than into others, it may be well to reconsider the hypothesis.

The functional sensitivity of the rods is indicated by the scotopic ocular visibility curve[4]. Their actual sensitivity has probably been most accurately expressed by the scotopic retinal visibility curve in terms of quanta obtained by Ludvigh[5], which among other things makes allowance for the absorption by the eye media. The maximum sensitivity of the rods lies at about 500 mμ, and the curve shows remarkable resemblance to the absorption spectrum of visual purple. Although the curve is normally obtained under conditions in which large quantities of this substance are present in the rods, there is no reason for believing that the differential sensitivity of the rods to different wave-lengths would change under daylight conditions when most, but probably not all, of the visual purple has been bleached. Indeed, Granit[1] has adduced evidence to show that, at any rate in guinea pigs, the rods do function in daylight and with the same differential sensitivity. Dark adaptation and the power to accumulate large quantities of visual purple in the rods may well be a secondary specialization of a more fundamental rod activity.

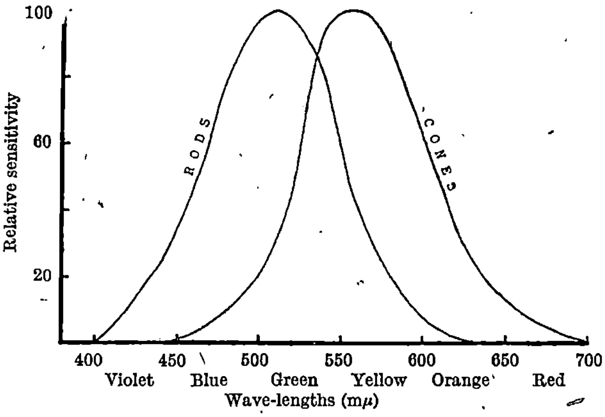

Fig. 1. SCOTOPIC AND PHOTOPIC VISIBILITY CURVES (EQUAL ENERGY SPECTRUM).

The functional sensitivity of the cones is probably closely represented by the photopic ocular visibility curve for the fovea obtained by Sloan[6]. Again, their actual sensitivity is seen in the photopic retinal visibility curve in terms of quanta recently obtained by Ludvigh[7]. The supposition that these curves represent cone activity receives direct support from Granit's observations in which the existence of a dominator is coincident with the presence of cones in the retina, and further support comes from the visibility curves for pure cone retinæ in which the maxima lie in the neighbourhood of 560 mμ. Recent determinations of this curve for the human eye by Ludvigh[7] show it to be remarkably symmetrical, a fact which he considers to favour the view that it represents either the absorption spectrum of a single substance or of a large number. He does not believe it to be consistent with the idea of three or four cone types such as would be required by the Young-Helmholtz theory in its popular form. Fig. 1, in which scotopic and photopic ocular visibility curves are plotted (equal energy spectrum), shows that the human retina in fact contains two elements which are differently sensitive to all regions of the spectrum and, if the rods are capable of functioning in daylight as well as in twilight, as we have seen to be possible, the retina thus contains the minimal necessary apparatus for discriminating between wave-length and intensity.

The visibility curves are essentially sensitivity curves. It is probable, however, that the responses given by the rods and cones are more or less directly related to the sensitivity of these elements and therefore we may properly consider the curves to some extent as response curves and think of the ordinates more in terms of impulse or discharge frequency, probably multiplied by some factor, than in terms of percentage of maximal sensitivity. It is therefore clear that for any wave-length there will be a characteristic ratio of impulses initiated from rods and cones and it will be well to consider the destination of these impulses. Unfortunately the neural connexions of the retina are extremely intricate, but in spite of this a few fairly definite conclusions may be drawn[8]. A great many of the cones, particularly in the regions of greatest colour sensitivity, are separately and individually connected with optic nerve fibres through midget bipolars and midget ganglion cells. It is almost equally certain that a great number of cones project their impulses together with those from more or less adjacent rods on to 'flat bipolar' cells. Thirdly, it is probable, though here we are on less certain ground, that over much of the retina the 'mop bipolar', or 'rod bipolar' of Cajal, conveys impulses arising in rods only. The 'rod bipolar' is absent from the foveal slope and it may be significant that foveal colour vision is weakest for those colours which are seen from Fig. 1 to be purely rod mediated, namely, the violet. Incidentally, it may be pointed out here that in those regions of the spectrum where impulses are propagated from rods or cones alone, that is, at the ends of the spectrum, the eye has no power of discrimination between wave-length and intensity. Returning again to the neural connexions, it is clear that the impulses set up by rods and cones may be transmitted to the brain by at least three routes, each one of which will convey a characteristic frequency of impulses for any given wave-length. If the intensity of the light be varied, the frequency along each route will vary coincidently so that the rod-cone response ratio for any wave-length will remain more or less the same. Much of the detailed analysis of the mechanism must depend upon the nature of this relationship between intensity and frequency of response. Owing to the present lack of direct information on this point the subject must remain one for conjecture and further experimentation. It may, however, be stated that the subjective changes in hue towards blue and orange seen upon increasing the intensity of violet and red light respectively are changes in the direction expected upon the hypothesis under discussion.

Much, of course, will also depend upon the nature of the interaction of the rods and cones when they are both projecting on to the same flat bipolar cell. Presumably there must be some form of summation or of inhibition. There is no direct evidence for either, and there is something to be said in favour of each. Antagonism or inhibition is suggested on grounds of comparative anatomy and physiology. For example, in those animals which have contractile bases (myoids) to both rods and cones, it has been observed that when the rod myoid contracts the cone myoid extends, and vice versa[9]. Inhibition also suggests itself as an explanation of the 'off effect' in electroretinograms. For example, when white light is acting on the retina the rods and cones may completely antagonize each other in their effects upon the flat bipolar cells except perhaps at the beginning ('on effect') and end ('off effect'), when their activities may not be completely synchronous owing to differences in reaction time. Moreover, there is the very interesting observation of Kravkov[10] that the sensitivity to certain colours may be changed, after some thirty minutes, by the application of a few drops of 1 per cent pilocarpine or of 1 : 1,000 adrenalin to the eye via the conjunctival sac. Adrenalin was found to increase the sensitivity to blue-green and reduce it to orange. It was found to have no effect on the colours at the ends of the spectrum, where rods and cones act independently, and there was a neutral or stable point in the yellow-green, strongly suggestive of the point of intersection of the rod and cone curves of Fig. 1. Precisely the reverse effects were obtained with pilocarpine. If this phenomenon be definitely shown to be retinal in origin, it would be explicable in terms of the balance of response set up by rods and cones, but it is difficult to incorporate into current theories.

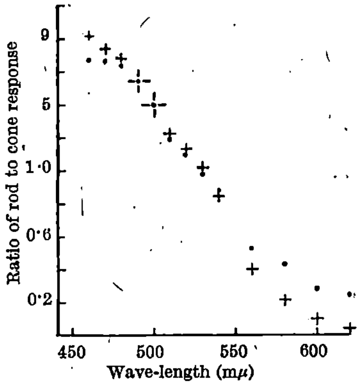

Fig. 2. Rod to cone response ratio observed (crosses) and calculated from colour equation (dots). Wave-lengths of primaries 619, 540 and 466 $m\mu$.

The analyses of retinal activity recorded by Granit[1] are all based upon impulses picked up from optic nerve fibres and therefore are not necessarily recordings from the sensitive elements themselves but from retinal units. For example, it would be possible to interpret his dominator as the response of the cone unit and his modulators as the rod-cone units or rod units.

Any theory of colour vision must satisfactorily explain such things as saturation, hue discrimination, colour contrast, colour fields, colour mixture and complementary colours, colour blindness and so on. It is impossible within the limits of this article to show how each of these can be interpreted on the basis of rod and cone activity, but two or three particular points may briefly be discussed.

The equation $Q = aR + bG + cB$, expressing the relationship between the intensities (a, b and c) of the three primary colours (R, G and B) required to match any given colour (Q), can be modified by substitution for R, G and B the ratio of rod response to cone response, that is, R_1/C_1 for the red primary, R_2/C_2 for the green and R_3/C_3 for the blue. The three primaries are chosen so that $R_1+R_2+R_3=C_1+C_2+C_3$; that is, so that the total rod response is equal to the total cone response, which is the condition for the perception of white light so long as the total intensity is great enough. If this modification be carried out and the values of a, b and c for any given colour be read from the C.I.E. colour chart, the value of Q turns out to be the rod to cone ratio for the colour match. The extent of this agreement is indicated in Fig. 2, where the observed and calculated values for spectral colour matches are plotted together.

Consideration of Fig. 1 might suggest that any combination of rod and cone responses, and therefore any colour sensation, should be obtainable by suitably mixing an extreme violet, stimulating rods only, with an extreme red, stimulating cones only. The effects of raising the light intensities at these wave-lengths sufficiently to produce the necessary rod and cone responses have, however, to be considered. It is significant that the purples obtained by mixtures of red and violet can be converted into white by the addition of a suitable green.

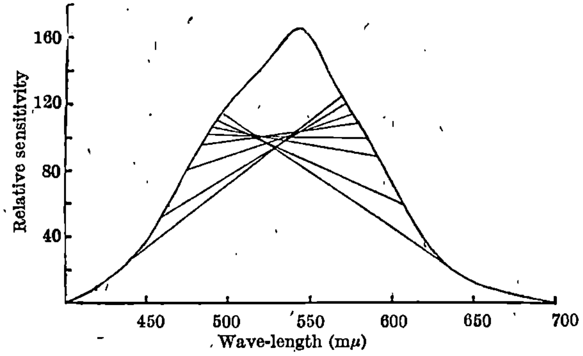

Fig. 3. SUMMATION OF SCOTOPIC AND PHOTOPIC CURVES; COMPLEMENTARY WAVE-LENGTHS CONNECTED BY STRAIGHT LINES.

A particularly interesting, though somewhat mysterious, confirmation of the hypothesis is obtained from a consideration of the effects of summating rod response and cone response. Physiologically, such summation might occur on the bipolar cells or on ganglion cells. The exact position of its occurrence is for the present irrelevant. When the scotopic and photopic visibility curves are summated, the curve shown in Fig. 3 is obtained, and it is clear from a study of this figure that such a curve has all the salient characteristics of the previously entirely empirical colour triangle. The lines joining points on the curve corresponding to complementary pairs all pass through nearly the same point; all wave-lengths shorter than 440 mμ or longer than 640 mμ are complementary to 570 and 496 mμ respectively, and greens can only have purples as complementaries. In this diagram the limits of the spectrum turn outwards, whereas in the colour triangle they are generally represented as turning inwards. The interpretation of this whole phenomenon is obscure, but its significance as a confirmation of the essential part played in colour vision by the facts described by the rod and cone sensitivity curves is manifest.

So far it has been tacitly assumed that, owing to the adaptation powers of the retina, rod and cone responses can be represented on the same scale, that is to say, the visibility curves can be directly compared in order to estimate the frequency of impulses travelling up the separate rod and cone fibres. This is the simplest assumption and may be used as a working hypothesis. It means that should, for any reason, the sensitivity of the rods with respect to the cones be increased or decreased, then some form of colour blindness would result. For example, many of the properties of the deuteranope would receive an explanation if his rods were relatively less sensitive than his cones. Similarly, the protanope would possess rods which were more sensitive than normal relative to the cones. Such quantitative variations in sensitivity of existing units would seem to be a more probable explanation of at least certain types of abnormalities of colour perception than the presence or absence of whole systems of hypothetical sensory units.

These selected points may be sufficient to indicate at least the possibility of interpreting colour phenomena in terms of the known activity of rods and cones. Naturally, there are difficulties, not the least of which is the structure and behaviour of the fovea, but these may perhaps yield to further investigation, and the hypothesis has the merits of not multiplying the sensory elements and of not invoking any structures which are not demonstrable.

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SCIENTIFIC DISCOVERIES BY ACCIDENT

By T. LL. HUMBERSTONE

FORTUNA favet fatuis is a familiar Latin tag. Mad or sane, the man of science must thank fortune or accident for useful discoveries in medicine, physics and chemistry. Pasteur said that chance favours those who are prepared. Accidental discoveries may have been forfeited owing to complete concentration on the primary object of the research. But those recorded are numerous. A few examples will demonstrate their value and variety.

Minkowski and von Mehring investigated the pancreas in relation to digestion. A laboratory attendant noticed that the urine of a dog deprived of its pancreas attracted swarms of flies. This was due to increased sugar content. The link between diabetes and the pancreas was established; the disease had been artificially induced and the way was open to Banting and Best for the discovery of insulin. Sir Lauder Brunton declared that his discovery of the effect of nitrites in dilating the arteries was accidental. For sufferers from that cruel disease *angina pectoris*, the drug acts like a charm. Diathermy and the induction of artificial fevers, new and important methods of treatment, were due to a feeling of discomfort noticed by one of Willis R. Whitney's assistants in attending to a high-frequency transmitter. Koch discovered how to separate microbes in a mixed culture through a half-potato left on his laboratory bench. By chance, two medical men discovered that mumps may cure whooping cough. Prof. Archibald Fleming's recent discovery of the bacillus-devouring power of *Penicillium notatum* was due to a chance observation.

In physics, chance discoveries have added to the wealth and happiness of mankind. A spectacle-maker of Middleburg who looked at a weathercock through two lenses was surprised to see an enlarged and inverted weathercock. The discovery was of value for war purposes. Galileo used the telescope to reveal the wonders of the heavens. He died in 1642, the year of the birth of Newton, exemplar of another method of scientific discovery, "travelling through strange seas of Thought, alone". Newton invented the reflecting telescope, the prototype of which is still in the proud possession of the Royal Society. The last—under construction in California—will in due course reveal new heavenly wonders. With apologies to Aristophanes, we may suggest that the frogs of Galvani are the most famous in the world. They hanged by a copper hook from an iron balcony. Galvani noticed that the dead frogs twitched when the wind brought their bodies into contact with the balcony. Thus the galvanic current was discovered, followed by the Voltaic pile, forerunner of the storage battery. Sir Richard Gregory in his book "Discovery" recalls that the Danish professor, Oersted, discovered induced currents by chance during a lecture experiment in 1819. Ampère, the French physicist, suggested that induced currents could be used for signalling at a distance, and two German men of science, Gauss and Weber, invented the first magneto-electric telegraph in 1833, a happy example of international co-operation in science. During Morse's experiments on telegraphy, a mile length of wire alongside a canal broke accidentally. Why not use the water of the canal ? Röntgen and Becquerel were favoured by chance in their important researches.

Iodine was accidentally discovered in 1811 by Courtois in the mother liquor of kelp. In those pre-Mendeléeff days, no chemist would deliberately set about its discovery. Colonel Silver records that ebonite was discovered by the accidental over-vulcanization of a rubber ball. The hypnotic property of sulphonal was discovered by chance. Antipyrine, an invaluable drug, was in a sense a chance discovery. The cyanide industry, of great value to Germany, resulted from the accidental discovery of Prussian blue by Diesbach early in the eighteenth century. That most useful gas, acetylene, was discovered by accident. The American, Willson, and the Frenchman, Moissan, re-discovered calcium carbide in 1892, working independently. Willson heated a mixture of coke and lime in an electric furnace in the hope of obtaining calcium. The resulting grey fusible mass was allowed to fall into a bucket of water and a copious supply of acetylene was produced. Chemists know of the result of a broken thermometer in relation to the oxidation of naphthalene and the synthetic indigo industry. Electro-plating benefited through a workman throwing his comrade's lump of cheese into a vat !

"Webster" defines chance as a supposed material or psychical agent or mode of activity other than force, law, or purpose. Force is as mysterious as space or time ; law in its scientific sense a somewhat fly-blown idol ; purpose in its teleological sense a vague aspiration. Chance relates to statistics, that queen of sciences, sadly contemned during the present War. We daily see provision made at great expense for war contingencies without regard to the principles of statistics and insurance. Nevertheless, physical science teaches that the most improbable events may happen. Stunned and stupefied by the wonders of modern science, the humble disciple is almost forced to the apostasy—*Credo quia impossibile est*. Was Newton a freak of Nature, due to some capricious combination of genes ? Will the world be reduced to chaos by fortuitous collisions of electrons thrown out of their orbits ?

Let us light a candle to the goddess of chance for boons received, for perils avoided !

Chance of chances, all is chance, says the Preacher. In a milligram of radium, about 500 million atoms disintegrate every second, each giving its characteristic radiation. How are these selected for destruction ? Not by seniority nor by lot like shipwrecked mariners on a raft, says Sir James Jeans in his new book, "Physics and Philosophy". Are we offered an escape from determinism, from "the forbidding materialism of the Victorian scientist" ? In the substratum below space and time, Jeans suggests, there may be springs of events including our own mental activities. The world made safe by democracy ! Chance may be "the unsearchable dispose of highest wisdom". *Quien sabe ?*

OBITUARIES

Dr. F. S. Sinnatt, C.B., M.B.E., F.R.S.

The death of Dr. Frank Sturdy Sinnatt on January 27 at the comparatively early age of sixty-two has removed from the ranks of technical science one of its important figures. He was director of fuel research to the Department of Scientific and Industrial Research, succeeding Prof. C. H. Lander in 1931.

Born in Jersey in 1880, Sinnatt was educated in Manchester, graduating M.Sc.(Tech.) in chemistry from the College of Technology in 1901. He obtained his D.Sc. at Manchester in 1930 and was elected a fellow of the Royal Society in 1935.

Originally a lecturer in organic chemistry under Sir William Pope, Sinnatt became interested in coal at an early stage in his career, and from personal research extended his work on the subject by organizing lectures in fuel technology and interesting university students in this relatively new branch of science. Coal technology fascinated him and soon absorbed his entire scientific interest. His researches and lectures attracted the attention of the local coal owners, and in 1918 he organized with them the Lancashire and Cheshire Coal Research Association and eventually became its first director. In 1924 he was appointed by the Department of Scientific and Industrial Research as assistant director of fuel research and as superintendent of the Fuel Research Coal Survey. In 1931 he succeeded Lander as director.

Sinnatt's published papers go back so far as 1906. Two early researches (1923), which are still of academic and technical interest, are the carbonization of coal in the form of fine particles for the production of cenospheres, and the mechanism of the combustion of coal in the form of fine powder. In addition, his method for representing the structure of coal in coal seams is still in use. His papers on the examination of coal in the ground represent the first organized series to appear in Great Britain. His later publications are based mainly upon the work of the Fuel Research Station and the Fuel Research Coal Survey.

Sinnatt was thus not only one of the pioneers of survey work in coalfields, but also it is mainly due to his efforts that the National Survey of Coal Resources in Great Britain is so far in advance of coal surveys started in other countries. The records of the Survey have proved invaluable in war-time in defining the properties of industrial coals and in serving as a basis for allocating these coals to their most appropriate industrial purposes. In general research work also Sinnatt's fertile imagination and infectious enthusiasms were an inspiration and example to his staff.

Sinnatt's interests, however, were not limited to his own organization, since he played an active part in the work of other scientific bodies. He served on the councils of the Institution of Mining Engineers, the Institute of Fuel, the British Colliery Owners' Research Association and the British Coal Utilisation Research Association, and he was a member of the British National Committee and Executive Committee of the World Power Conference. In addition, he was a member of the Iron and Steel Industrial Research Council and chairman of the Blast Furnace Scientific Panel. He was also an original member of the Coal Research Club, an informal group of coal technologists formed just after the War of 1914–18 to further coal research and with the special object of prediscussion of papers intended for publication. In forming this Club he was associated with other personalities well known in fuel technology such as Lessing, Stopes, Wheeler and Seyler. In all these wide activities Sinnatt's opinions and views were greatly appreciated.

Although in later years Sinnatt used up all his energies in the pursuit of science, he had had diverse interests in early life, of which the most important was military training. He joined the Territorial Army in 1908, went to France as a member of the Special Brigade, R.E., in 1915, and later, when forced on medical grounds to return to Great Britain, he assumed command of the University of Manchester O.T.C.

His enthusiasm and kindly personality will be sadly missed by the many people with whom he came into contact, and particularly by the staff of the Fuel Research Organization. J. G. King.

Prof. Rudolph Abel

News has reached Great Britain of the death on his seventy-fourth birthday of Rudolph Abel, professor of hygiene at the University of Jena. Born on December 21, 1868, in Frankfort-on-Oder, Rudolph Abel worked as assistant in Loeffler's laboratory at Greifswald, becoming *Privat-Dozent* in 1893, and afterwards in 1896 assistant at the Institute of Hygiene in Hamburg.

Abel devoted himself particularly to problems more directly concerned with hygiene, publishing many papers dealing with public health and the measures to be taken in combating such diseases as diphtheria and smallpox. He was drawn into the discussion that took place after the War of 1914–18 upon the effect which mass anti-typhoid inoculation of the male population had upon the relative incidence and mortality of typhoid in males and females in subsequent years. The rates for males were found to be very definitely lowered in comparison with those for females, and in this way a reliable indication of the lasting prophylactic effect of the war-time inoculation was obtained. He was consulted as an authority in the judicial trial which followed upon the tragic infections that occurred in Lübeck after the use of Calmette's B.C.G. vaccine.

As a *Privat-Dozent* at Greifswald under Loeffler, a chief whose name, with that of Klebs, will always be associated with the discovery of the diphtheria bacillus, Abel very naturally took a prominent part in the investigations of a number of problems concerned with the natural history and epidemiology of this important organism. The ground for further progress had been recently greatly cleared by Behring's discovery in 1890 of diphtheria antitoxin. Perhaps the most important discovery by Abel in this field was the demonstration in 1894 of the presence of diphtheria antitoxin in the blood of normal persons. This observation underlies much of the present-day practice of immunization against diphtheria. In the blood of diphtheria convalescents Abel found no antitoxin at the time of disappearance of the membrane, but some ten days later antitoxin appeared, only to vanish in the course of succeeding months. He made the suggestion, abundantly verified in recent years, that it is not the mere presence, but rather the amount, of diphtheria antitoxin in the blood that determines immunity.

To the carrier problem in diphtheria Abel made important contributions and also to the importance of fomites as potential sources of infection; in 1893 he had isolated virulent diphtheria bacilli from a box of bricks 6½ months after a child suffering from diphtheria had played with them. Another problem that greatly interested Abel while in his twenties at Greifswald, and to which he devoted a series of bacteriological contributions, was the etiology of certain nasal conditions, in particular ozæna or atrophic rhinitis associated with the presence of organisms of the mucoid-encapsulated group, of which the prototype is Friedländer's bacillus. In his article on these organisms contributed to "Kolle and Wassermann", and to the third edition of this work edited by Kolle, Kraus and Uhlenhuth, he strongly maintained the view that from the very start of the condition of atrophic rhinitis with its accompanying ozæna, an organism found by him and known as the *Bacillus mucosus ozænæ* played a causative part. Writing in 1938, he had to admit that his view of the etiological role of 'Kapselbacillen' in the causation of the ozæna process had not gained the acceptance of rhinologists, and indeed the precise part played by this interesting group of organisms in disease has scarcely yet been adequately elucidated.

To the great compendium of current bacteriological knowledge already alluded to, Abel provided the first chapter, dealing with the historical development of our knowledge of infective immunity throughout the centuries to the time of Pasteur. It is a concise account and should be read in conjunction with the detailed and fully documented study of this theme by Bulloch in his "History of Bacteriology", published in 1938.

After some ten or twelve years of research on pressing bacteriological problems, Abel became more interested in those of general hygiene in its relationship to the State, and he wrote widely on a variety of public health questions. In so doing he departed to some extent from the Koch tradition, which made it almost imperative that holders of chairs of hygiene in German universities should be predominantly exponents and practising professors of bacteriology. For this reason and in view of the fact that his work on bacteriology occupied only his earlier years, Abel's achievements are probably less known to present-day bacteriologists than those of many of his contemporaries who have occupied chairs of hygiene in Germany since the beginning of the present century.

He will, however, be chiefly remembered in Great

Britain as the author of a very popular "Laboratory Handbook of Bacteriology", translated and published in 1907. In Germany, other text-books from the same pen served as practical guides to bacteriology and hygiene and ran into numerous editions.

Abel received the honorary title of *Geheimer Medizinalrat* in 1906 and was appointed to the chair of hygiene at Jena in 1915.

Lord Hirst

Lord Hirst's death on January 23 at the age of seventy-nine has caused poignant regret in many circles, for he was one who touched British social life at many different points. But his outstanding contribution to national life is in the industrial field. That he founded, and built up, the General Electric Company is well known. That he set a new standard in staff relationships in industry, which gave that Company a unique character, is less well known, and is a tribute to the unerring instinct he had for singling out the essentials in all matters which he handled. In this he showed a true scientific spirit by realizing that industry is run by human beings, and broadly its organizations must be made to suit human instincts and aspirations, and not the other way round.

As soon as Lord Hirst felt his Company was large enough to support a big research laboratory, he was able to fulfil a long-standing aspiration and established the Research Laboratories of the General Electric Company at Wembley. His instinct for essentials is again to be noted. His chief objective in founding these laboratories was not the expectation of startling the world with new inventions, welcome as such have been to him when they came. His first object was to provide a scientific general staff for his Company, complete with the facilities which a large laboratory could give them.

The services of this scientific staff were not to be forced on the factory managements. They were to operate at the intermediate levels of the Company, by working on factory problems with the engineering and process staffs in the works. Most of those who are experienced in industry will concur with Lord Hirst in emphasizing this essential place in manufacturing industry, where science should have its beginning and its primary focus.

As soon as it was clear, in 1939, that war was coming, Lord Hirst gave instructions that the research laboratories of his Company, with all their staff and facilities, should be put at the disposal of the Government without regard to commercial considerations. This offer was accepted in the letter and the spirit. The scientific assistance which his laboratories were thus enabled to bring to the war effort was a chief source of satisfaction to Lord Hirst in the closing years of a great life.

C. C. Paterson.

NEWS and VIEWS

The Physical Society : Charles Chree and Duddell Medallists

The Council of the Physical Society has awarded the Charles Chree Medal and Prize for 1943 to Prof. (now Colonel) B. F. J. Schonland and the Duddell Medal for 1942 to Dr. C. R. Burch. Col. Schonland, formerly professor of physics at Cape Town and afterwards director of the Bernard Price Institute of Geophysics at Johannesburg, is now in Great Britain doing scientific work in connexion with the War. Dr. Burch, formerly of the Research Department of the Metropolitan-Vickers Electrical Company, has continued his work in the Physics Laboratories of the Imperial College and the University of Bristol.

Prof. Schonland's work on atmospheric electricity has been primarily concerned with thunderstorm phenomena : first his investigations of the 'polarity' of thunderclouds in South Africa, and his measurement of the discharge from a small tree, which clearly established the importance of point discharges in maintaining the earth's negative charge ; secondly, his systematic long-period observations on the inter-relation of thunderstorms and penetrating radiation in the southern hemisphere ; and thirdly, his use of a rotating-lens camera of the Boys type in a spectacularly successful series of systematic experiments which elucidated the rather complicated succession of discharges forming what is known as a 'stroke' of lightning.

As may be seen in some of the work of the two previous Duddell medallists—Lawrence's cyclotron and Coolidge's multi-sectional high-voltage X-ray tubes—one of the outstanding characteristics of modern physics is the large-scale application of vacuum technique. It is, primarily, in recognition of Dr. Burch's valuable contributions to the advancement of such technique that the present award of the Medal is made. His invention of the oil-diffusion pump, his still for the production of vacuum oils, greases and waxes, and his development of demountable vacuum-tight joints have made possible the attainment of high vacua on an engineering scale and thus greatly increased the range of experimental investigation. It was Burch's work on the production of flat surfaces for vacuum work that aroused his own interest in the grinding of optical surfaces and the possibilities of new developments in optical technique, on which he is now engaged. His remarkable versatility is seen also in his pioneer work in the invention (with Davis) of the induction furnace. In Dr. Burch we see a very rare combination : considerable mathematical ability, exceptional experimental skill, and ability not only to design his instruments but also to construct them in the workshop ; in him Duddell would have recognized a kindred spirit.

The Nuffield Foundation

Lord Nuffield, to whom the world is already indebted for numerous benefactions, large and small, for the benefit of research particularly in social studies, has handed over his holdings in the Nuffield organization to the value of £10,000,000 as a capital fund which will be known as the Nuffield Trust. The fund will be administered by trustees, not exceeding seven in number, and the income will be devoted to (1) medical research and teaching ; (2) organization and development of medical and health services ;

(3) scientific research and teaching in the interests of trade and industry; (4) social studies; (5) care and comfort of aged persons. The normal scope of the Trust's activities will be Great Britain and Northern Ireland. Attention may, however, be given to projects particularly affecting the British Empire, and in regard to items 1 and 3 the provision of scholarships and other assistance for Empire students is included. Lord Nuffield's trusts which are already in being may benefit from the income of the new Trust.

The following have been appointed trustees to manage the new fund thus created: Sir William Goodenough (chairman), who is associated with other Nuffield Trusts; Sir John Stopford (vice-chairman), vice-chancellor and professor of experimental neurology in the University of Manchester; Prof. F. L. Engledow, Drapers' professor of agriculture in the University of Cambridge; the Hon. Geoffrey C. Gibbs; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; Sir Henry Tizard, president of Magdalen College, Oxford, and formerly rector of the Imperial College of Science and Technology; and Miss Janet Vaughan, who is a fellow of the Royal College of Physicians.

Science and Government

THE second annual luncheon of the Parliamentary and Scientific Committee, held on February 11, was attended by several members of both Houses of Parliament, including three Cabinet ministers, and by representatives of the associated scientific bodies. In an address on the organization of scientific effort in Great Britain, Sir John Anderson, Lord President of the Council, who has now become responsible for the Government's scientific services, recalled that Sir Stafford Cripps had already outlined the existing arrangements for scientific research and development in his address on January 30 before the conference on "Planning of Science: in War and in Peace" (see NATURE, February 6, p. 152). Sir John devoted himself therefore to the general principles which he believes should govern such arrangements. He believes that four main conditions must be satisfied: the organization must be an integral part of the Government machine; it should maintain contact with outside scientific bodies; it must not cut across normal ministerial responsibilities; and it must be linked up with a minister who is in a position to see that extra-departmental considerations are not neglected. The present organization of scientific effort, with the scientific advisers to the Ministry of Supply, the Scientific and Engineering Advisory Committees and so on, is, in Sir John Anderson's opinion, meeting these requirements tolerably well, and will provide a good basis on which to build up the type of organization required for the post-war world. Sir Robert Robinson spoke on the importance of the international control of explosives. As all the explosives in use by armed forces depend on the supply of nitrates, he urged the control of synthetic nitrate and similar plants as a measure for ensuring that aggressor nations shall not resort to war.

Parliamentary and Scientific Committee

ACCORDING to the annual report for 1942 of the Parliamentary and Scientific Committee, the membership now includes thirty-three organizations associated with scientific work and seventy-four members of the Houses of Parliament. During the past year, the main work of the Committee has been connected with the better utilization of scientific men in the war effort. A memorandum on the subject was prepared and a strong deputation saw Mr. R. A. Butler, then chairman of the Scientific Advisory Committee. Later, a motion urging the establishment of a Central Scientific and Technical Board was tabled in the House of Commons. This motion was allowed to lapse, after several questions designed to elucidate the position had been asked in the House, on the understanding that the functions of the scientific advisers to the Ministry of Supply would be widened as they became established. The Committee is watching the position. Discussions arranged during the year dealt with the dissemination of scientific knowledge among farmers (see NATURE, June 27, p. 722), the Industrial Health Research Board, the use of geology in war-time, pasteurization of milk and visual efficiency in factories. The secretaries of the Committee have continued to issue *Science in Parliament*, which summarizes important Parliamentary proceedings relating to science and technology. The following officers have been appointed for 1943: *President:* Lord Samuel; *New Vice-Presidents:* Captain L. F. Plugge, M.P., Prof. B. W. Holman, Mr. R. B. Pilcher (Institute of Chemistry); *Chairman:* Mr. E. W. Salt, M.P.; *Vice-Chairman:* Prof. J. A. Crowther (Institute of Physics); *Deputy Chairman:* Mr. M. P. Price, M.P.; *Hon. Treasurer:* Mr. C. S. Garland (Institution of Chemical Engineers); *Hon. Secretary:* Dr. W. R. Wooldridge (National Veterinary Medical Association).

Colonial Policy

A SOMEWHAT inconclusive debate on Colonial affairs took place in the House of Lords on February 9. The matter was raised by Lord Trenchard, who asked whether the Government could make any statement on methods of staffing and administering the Colonial Empire. Lord Trenchard referred to his previous inquiry on the subject last May, when he brought forward five matters for discussion: recruitment of the Colonial Civil Service, organization of a single interchangeable and independent Service, a Colonial Staff College, creation of a Colonial Advisory Board, and the possibility of grouping the Colonies into larger units. In the interval, other debates on the general subject have taken place, and in one of them Lord Listowel remarked that we now have an opportunity for atoning for past neglect of the Colonies. Lord Trenchard emphatically repudiated the suggestion that there has been neglect, showing that the British Colonial administration has brought peace and prosperity in its train; and he denied the suggestion that Great Britain has enriched herself at the expense of the Colonies. This point, it may be noted, was also made by Mr. R. G. Casey, now Minister of State in the Middle East, and a former member of the Australian Government, in a broadcast address delivered on February 14. Lord Listowel followed Lord Trenchard and discussed particularly the staffing and recruitment of the administrative services. He pointed out that high academic achievement is insufficient, and should be supplemented by special courses taken after having practical experience in the Colonies. Lord Elibank referred particularly to the difficulty of grouping Colonies. The importance of introducing local inhabitants into the administrative system was widely emphasized.

The Duke of Devonshire, Parliamentary Under-Secretary of State for the Colonies, replied to the debate. He said that the Colonial Office is not so academic as is often assumed; adding that he generally finds someone with first-hand and recent knowledge of any particular Colony at his immediate disposal. As regards suggestions for improvements in recruitment, they would be borne in mind; he pleaded that difficulty of war-time communication has made consultation slow and laborious. The Colonial Service consists of individuals employed under a variety of geographical conditions by a variety of Colonial Governments; European officers form only a small fraction of the whole. Hence re-organization of the Service is a matter, not for the Colonial Office alone, but for legislative bodies all over the world. Two main principles of development must be recognized; there must be partnership of the Colonial peoples in administration, but a substantial body of officers of European stock is still necessary to supplement local man-power. The formation some thirteen years ago of a series of unified professional services has provided a pool of highly qualified men who can be posted to any Colony and moved from one to another. Nevertheless he agreed that there should be nothing static in Colonial administration, and the whole position as regards this and other points raised is being examined in association with the Colonial Governments.

Packaging Research Committee

The Printing and Allied Trades Research Association has set up a Packaging Research Committee to carry out investigations concerned with packages of which paper, board, film or foil form the main part. The research work will be carried out by the Association, which will set up a new department for the purpose, using its own laboratories or other research organizations as may be most appropriate. Preliminary consideration will be given to the systematic investigation of the elementary principles of the relation between the make-up of packages and their performance in use. The Association will also collect empirical data from individual firms in Great Britain and abroad with the view of obtaining a basis for long-range research. The outline programme already drawn up includes investigations on the penetration of various packaging materials by vapours, liquids, gases, heat and light, the effect of impregnation with various materials, damage by pests, design of packages, methods of sealing, and optimum use of automatic packaging machinery. Some ninety members of the industry have already applied for membership under the scheme. Communications should be addressed to the Director of Research, Printing and Allied Trades Research Association, 101 Princes Gardens, Acton, London, W.3.

Race Theories

On February 8 a well-attended meeting of the Manchester University Branch of the Association of Scientific Workers heard a lecture on "Race Theories" by Prof. F. Wood Jones. The differences between various types of men are sufficient for them to be classified in three distinct species, the leiotrichi or mongol, the ulotrichi or negro, and the cymotrichi. The last-named species, to which we belong, is rather less easy to define. Since interbreeding between the species readily occurs, the view that there is only one species, *Homo sapiens*, has been widely held. Numerous zoological and botanical examples of the interbreeding of species with the production of fertile offspring are now known, and it is therefore again justifiable to speak of three distinct species, particularly as they can be distinguished in embryo less than three months old, as well as in fossil remains of the pleistocene period. Within these species are numerous sub-species or races, each with distinct characteristics. Segregation whether geographical, or religious and political as in the case of the Jews in Europe, tends to produce such races. Nevertheless in Europe at the present time there is no nation in which more than 10 per cent of the population belongs to a pure race. The belief that half-breeds of certain races inherit the worst qualities of both races is quite unfounded. The belief probably arose because in certain cases only the least desirable elements in both races produced such half-breeds. Professor Wood Jones strongly advocated intermarriage between all races.

Multi-part Domestic Electrical Tariffs

A paper under the title "Towards the 'Correct' Domestic Multi-Part Tariff" was read by P. Schiller before the Institution of Electrical Engineers in London on February 4. The author pointed out that the principle of multi-part costing and charging is again attaining particular importance in the intensive development of the domestic thermal load, which requires the unit charge component of multi-part tariffs to be reduced to the bare minimum. The necessary corollary of allocating to the standing-charge component the bulk of the actual standing costs involved in giving supply is impracticable with conventional two-part tariffs. At present the standing charge covers little more than the standing costs due to the demand for lighting and small domestic appliances, which is but a small fraction of the total demand of modern domestic installations. Hence the bulk of the standing costs due to the domestic thermal load must be averaged out on the unit-charge component.

A 'correct' domestic multi-part tariff must take account of the individual consumer's demand, and this becomes more and more justifiable as inter-consumer diversity grows poorer in consequence of the predominance of the space-heating load. Owing to the rigid character of lighting and cooking demands, it appears to be sufficient to consider the individual consumer's demand only in connexion with the elastic requirements of water-heating and space-heating. Tariff charges based on actual demand can be put into effect by either recording or limiting consumers' maximum demands during periods of heavy load on the general supply system. As to the second alternative, the 'contract-demand' method can be developed to such an extent as to be capable of everything the maximum demand indicator method achieves, while obviating the drawbacks of the latter. Thus a 'correct' domestic multi-part tariff may be found in a revival and modernization of the contract-demand method. Whether such a tariff is also an ideal one is open to discussion. But the principle of charging domestic supplies on the basis of both consumption and demand is worth reconsidering at all events.

Boiler-House Measurements and Control

A paper by G. H. Barker and A. L. Hancock, read before the Institution of Electrical Engineers in London recently, on boiler-house measurements with special reference to the efficient utilization of fuel, reviews the development of boiler-plant instrumentation from the early use of measuring instruments as mere safety devices to the modern employment of remote centralized control, based upon the comprehensive measurement of the operating conditions. As improvements in plant design and operating efficiency are governed by the degree to which their dependent factors are known and understood, exploratory measurement must embrace all the measurable quantities, while the operating measurements must include those of all the variables which are susceptible to regulation. A table of essential measuring instruments for shell-type and water-tube type boilers is included in the paper. Remote manual control is compared with automatic control in order to show that, as measurement is now the acknowledged basis for control, it follows that the measuring instruments which detect and report the adverse tendencies should be used to institute the corrections needed to arrest them, wherever this is practicable.

Standards of Electrical Measurement

Dr. L. Hartshorn has written an interesting progress review on this subject (*J. Inst. Elect. Eng.*, 89, Pt. 1, No. 24; Dec. 1942). Following introductory paragraphs dealing with the general character of measurement, an account is given of the more recent experimental researches of the standardizing laboratories, and of the present legal and international position of the various electrical units. The review is presented under the headings of units and standards, fundamental and derived measurements, the absolute system and the international position. The section on the absolute system deals with the measurement of inductance, current, resistance and voltage, capacitance and quantity of electricity, power and energy, practical standards, and frequency. The remarks relating to the international position give prominence to the M.K.S. system.

Maternal and Child Welfare in Venezuela

Discussing maternal and child welfare in Venezuela (*Bol. Of. San. Panamericana*, November 1942) Dr. Pastor Oropeza refers to the creation in 1936 of the Ministry of Public Health and Social Welfare as providing a sound foundation. At the present time, these services are under the direction of the Division of Maternal and Child Hygiene. The Ministry operates through health units and health centres, and offices in places where centralized local public health services have not been organized. In 1942 there were 37 fully qualified health units, 4 health offices and 61 rural medical officers. Regulations have been issued for the supervision and education of midwives. In 1936, pregnancy was made the subject of industrial legislation. Obstetrical assistance and post-natal care are given to the wives of insured workers. The official infant death-rate has fallen in Venezuela from 124 per 1,000 live births in 1936 to 121 in 1940, but these figures are probably inaccurate owing to many births not having been registered until baptism, and numerous deaths were probably not reported. Child welfare work includes examinations and immunizations carried out by the various health centres, assisted by public health measures. During 1930–41, 45 stations for distribution of milk to children were organized throughout the country in connexion with health centres. Attention is also given to the care of sick children mainly through the welfare agencies of the States and municipalities. Other developments include the creation of a course in clinical pædiatrics and puericulture, and a new law making these subjects compulsory for medical qualification.

Commemoration of Copernicus in the United States

The Kosciuszko Foundation of New York is making arrangements to celebrate the four hundredth anniversary of the death of Copernicus on May 24. Invitations to take part have been sent to American universities and other institutions by Dr. Henry N. MacCracken, president of Vassar College and also of the Kosciuszko Foundation. With Poland now associated with the United States in the war of survival and several million citizens of Polish extraction living in the United States, it is the desire of the Foundation to make the occasion an outstanding event in the history of science.

Announcements

The Committee of the Athenæum has elected the following under the provisions of Rule II of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services: Sir William Stanier, scientific adviser to the Minister of Production; Sir Thomas Lewis, director of clinical research, University College Hospital; Sir Bernard Pares, lately professor of Russian history, University of London.

The Managers of the Royal Institution have awarded the Actonian Prize of one hundred guineas for the year 1942 to Dr. Alexander W. G. Ewing and Mrs. Ewing for their investigation concerning the detection, measurement and assessment of deafness, their pioneer work upon hearing aids, and the development of their successful technique for education by the 'hearing lip reading' method.

Dr. Robert E. Wilson, president of the Pan American Petroleum and Transport Company, has been awarded the Perkin Medal of the American Section of the Society of Chemical Industry for outstanding work in applied chemistry. His work includes research on such varied subjects as flow of fluids, corrosion, motor fuel volatility and contributions in the use of tetraethyl lead.

The Institute of Industrial Administration is organizing a Conference on Training for Industrial Management, to be held at the Waldorf Hotel, London, during March 5–7. The opening session on March 6, on "Management and Nation", will be addressed by the Archbishop of Canterbury. Other sessions will be devoted to the position of management in industry, external and internal training for industry, and the training required by a director. Particulars can be obtained from the Institute, Artillery House, Artillery Row, London, S.W.1.

The Council of the Harveian Society of London announces that the subject of the Buckston Browne prize essay for 1943–44 will be the use and abuse of sulphonamides. The essay must be sent to the Treasurer of the Society, 14, Devonshire Street, W.1, by October 1, 1944.

The German Academy of Natural Science at Halle proposes to issue an edition of Goethe's scientific works.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Stability of Ascorbic Acid in Metaphosphoric Acid Extracts

It is frequently impossible to perform an analysis of ascorbic acid in foods immediately after sampling. In some cases a delay of as long as 24 hours is unavoidable, and doubts have arisen as to the reliability of the results then obtained. Most analysts now employ metaphosphoric acid or a mixture of metaphosphoric and trichloroacetic acids as the extractant, when determining ascorbic acid by titration against 2,6-dichlorophenolindophenol. We have accordingly investigated the rate of oxidation of ascorbic acid in 5 per cent metaphosphoric acid solution and in a mixture containing 2 per cent metaphosphoric acid and 5 per cent trichloroacetic acids. The solutions were pure ascorbic acid and extracts of cabbage, potato and swede.

Ascorbic acid suffers photochemical decomposition if exposed to light, when present either in pure solutions or in foods such as milk[1,2,3]. Kellie and Zilva[4] found that the destructive influence of light was less at *p*H 3·0 than at alkaline reactions. We have found that even in very acid solutions (5 or even 20 per cent metaphosphoric acid), ascorbic acid is not stable unless the solutions are kept in the dark.

Fig. 1 shows that, in the dark, pure ascorbic acid was stable in 5 per cent metaphosphoric acid solution for at least 2 days at a temperature of 20° C., whereas if kept in daylight 50 per cent of the ascorbic acid was oxidized within 53 hours. When the solution was kept at 0° C., in the dark, there was no deterioration over a period of six days. Irradiation of the solution with ultra-violet light had an even greater destructive effect than daylight.

Ascorbic acid in extracts of various vegetables was less stable, whether in the light or in the dark, than were solutions of the pure acid. Thus ascorbic acid in a cabbage extract in a mixture of 2 per cent metaphosphoric and 5 per cent trichloroacetic acid was stable for two days when kept in the dark at 20° C. (Curve 1, Fig. 2), after which oxidation proceeded at an increasing rate until at the end of ten days 50 per cent of the ascorbic acid had disappeared. In swede extract made with 5 per cent metaphosphoric acid (Curve 2, Fig. 2) the oxidation was a little more rapid, but after twenty-four hours 95 per cent of the ascorbic acid remained in the reduced form. The stability of ascorbic acid in both cabbage and swede extract was increased if the extracts were kept at 0° C. in the dark; 5 per cent metaphosphoric acid extracts of cabbage or swede have both been kept for more than sixty hours without loss.

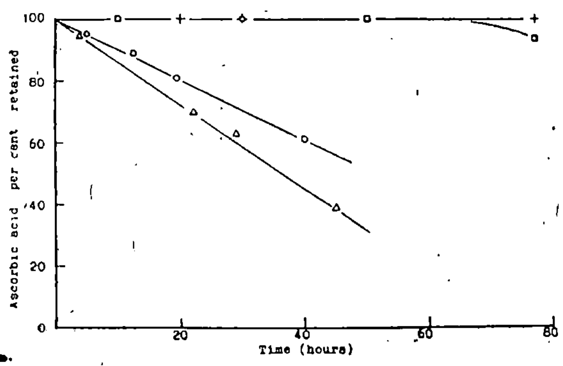

Fig. 1. STABILITY OF SOLUTION OF PURE ASCORBIC ACID IN 5 PER CENT METAPHOSPHORIC ACID.

△——△ Solution irradiated with ultra-violet light at 20° C.; ○——○ Solution kept in daylight at 20° C.; □——□ Solution kept in dark at 20° C.; +——+ Solution kept in dark at 0° C.

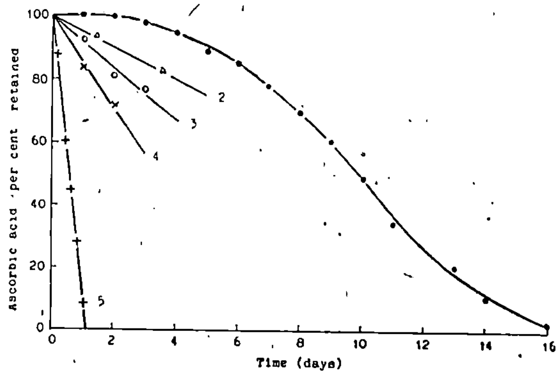

Fig. 2. STABILITY OF ASCORBIC ACID IN METAPHOSPHORIC AND TRICHLOROACETIC ACID EXTRACTS OF CABBAGE, POTATO AND SWEDE.

Solution 1. Cabbage extract: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid. Solution 2. Swede extract: 5 per cent metaphosphoric acid. Solution 3. Cabbage or potato extracts in contact with deposit: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid. Solution 4. Cabbage or potato extracts in contact with deposit: 5 per cent metaphosphoric acid.	Solution kept in the dark at 20°.
Solution 5. Cabbage extract: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid. Swede extract: 5 per cent metaphosphoric acid.	Solution kept in daylight at 20°

When the centrifuged deposit was left in contact with the supernatant acid extract, the ascorbic acid was oxidized somewhat more rapidly. Curves 3 and 4 show the rate of oxidation in the metaphosphoric - trichloroacetic acid mixture, and in 5 per cent metaphosphoric acid respectively at 20° C. Curves 3 and 4 have been constructed from analyses of samples of cabbage or potato which were estimated at once and after one, two and three days, and each point is the mean of the results obtained from a considerable number of samples. After twenty-four hours in the dark at 20° C., 91 per cent of the initial ascorbic acid remained in the metaphosphoric - trichloroacetic acid mixture, while in the 5 per cent metaphosphoric acid mixture the residual ascorbic acid was 85 per cent of the original amount. When kept in daylight, the rate of oxidation in these food extracts was increased to such a degree that 50 per cent of the ascorbic acid was destroyed within twelve hours (Curve 5, Fig. 2).

Comparison of these results with those in Fig. 1 shows that the rate of oxidation of ascorbic acid in metaphosphoric acid extracts of foods in daylight at 20° C. is some two to three times greater than that of the pure substance. This is not surprising in view of the presence in foods of substances such as copper, iron and riboflavin, which catalyse the oxidation of ascorbic acid.

Conclusion. Samples taken for analysis for ascorbic acid in 5 per cent metaphosphoric acid or a mixture of metaphosphoric and trichloroacetic acids should be kept in the dark if any delay between extraction and analysis is likely to occur. If the extracts are kept at 0° C. there should be no loss over a period of two days; if kept at room temperature analysis should be completed within twenty-four hours. Loss is less when the supernatant extract is separated from the precipitate.

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[2] Schroeder, H., *Münch. med. Wschr.*, 84, 1942 (1937).

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Automatic Separation of Wet from Dry Grain for Storage

WHEN wheat is too damp for prolonged storing, which is usually true of the home-grown crop in Great Britain, deterioration, accompanied by heating and development of fungi, is commonly observed to occur first in small patches buried in the bulk. These are the wetter portions of the bulk. If all the grain is very damp, heating may spread from these foci throughout the bulk; but even if this does not happen, development of fungi in such small areas may produce sufficient taint throughout the bulk to make the grain unfit for milling. This experience, common in the storage of English grain, has been confirmed in America by Kelly and others[1] by extended storage tests. Consequently, in so far as it is affected by water-content, the storage life of a bulk of grain depends on the maximum water-content at any point, rather than on the mean water-content of the bulk. Hence, for any mean water-content, the maximum storage life is reached when variations from the mean are reduced to a minimum. Such variations are greatest in grain harvested by combine, often because of irregularities in ripening in the field; but non-uniformity of water-content causes difficulty in storage of grain in Great Britain whatever method of harvesting is used. The variations might be brought to a minimum by thoroughly mixing every load of grain, but this is impossible without large-scale machinery, and even the handling plant of a large modern silo is barely adequate for the purpose. Consequently, it is seldom certain that grain in bulk is of uniform water-content. Nevertheless, mixing and thorough drying of the entire crop are the only methods at present available to ensure that English wheat shall have an adequate storage life. Increasing production is putting an extreme strain on drying facilities; therefore, an alternative to drying the whole crop is desirable.

The development of rapid electrical methods for the determination of water-content of grain has made it possible to design a machine to separate the wetter portions of a grain stream. This process will eliminate wide water-content variations while lowering the mean water-content of the bulk. After this separation the drier fraction (which may be a large proportion of the whole) will have a longer storage life than would be expected of a normal, more heterogeneous, bulk of the same mean water-content. The small wetter fraction may easily be given priority for drying. Because of its high water-content a greater amount of water will be removed by a given quantity of heat, or by a particular size of drier, than if the original bulk had been dried before separation.

The variations in water-content in a single freshly threshed bulk are so wide that a separator which would be capable of reducing this wide range very greatly need not act with great precision. Accordingly a simple physical measurement may be made the basis of operation. In this laboratory a machine has been constructed in which grain passes in a stream of constant thickness between two metal plates acting as a condenser. The current passed to earth by this condenser, when an alternating potential of constant frequency is applied to one plate, controls the separating mechanism. This consists of a hinged metal plate which diverts the stream of grain to either of two chutes according to the current passing through a spring-loaded adjustable relay. It has been found satisfactory to convey the grain stream between the condenser plates on a moving cotton band, but some mechanical disadvantages of this arrangement are overcome if the surface of a revolving cylinder is substituted for a moving band. A machine of this type, large enough to deal with grain in commercial quantities, is now under construction in this laboratory.

The total current passed by a condenser under the conditions described is partly capacitative and partly resistive, the proportions of each varying with the water-content of the grain between the plates. It cannot, therefore, be claimed that the condenser current measures with precision the water-content of the grain stream, but the precision obtainable is adequate for the purpose. If, for other purposes, a separator working at a more precisely defined water-content were required, a circuit of one of the types developed by Dr. Hartshorn, of the National Physical Laboratory, would be very suitable.

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Jan. 27.

[1] Kelly, C. F., Stahl, B. M., Salmon, S. C., and Black, R. H., "Wheat Storage in Experimental Farm-Type Bins", U.S.D.A. Circular No. 637, April 1942.

'Pasmo' Disease of Flax

DURING the summer of 1942 a culture of a fungus was received from Dr. R. M. Nattrass, of Kenya, who stated that the organism had been isolated from flax plants suspected of being affected with 'Pasmo' disease and that he believed it to be *Sphærella linorum* (Naoum.) Wr., the cause of the disease.

Examination of the fungus showed that its characters were in close agreement with those recorded for *S. linorum*. To investigate its pathogenicity, flax plants which were at the flowering stage were sprayed with a suspension of spores prepared from a single-spore culture. They were then covered with bell jars for four days. Lesions, identical with those described for 'Pasmo' disease, appeared on the plants some fourteen days after inoculation. The organism was re-isolated from pycnidia produced on these lesions and re-inoculated into healthy plants. Positive results were again obtained and the organism again re-isolated. Control plants sprayed with water at the same times remained healthy. Inoculation experiments were made both under glasshouse and open-air conditions and, in each case, infection resulted. Special precautions were taken to isolate the plants used in these trials, and they were destroyed immediately after the work had been concluded.

Lesions were produced on both leaves and stems, mainly on the upper portions of the plants. They were brown in colour and at first small, somewhat elongated, and extended only part of the way round the stem. Later, they increased in size and ultimately encircled the stem; it was common to find diseased and healthy portions of the same stem occurring alternately. As the result of encirclement, the portion of the plant above the lesion was frequently killed and this 'strangling' effect is aptly described by the common name given to the disease. Illustrations of typically infected stems, including an example showing how the top of the plant may be killed, are seen in Fig. 1. Fig. 2 is a photograph of a typical lesion showing the presence of pycnidia. In some cases the stem lesions are not unlike those produced by an attack of browning (*Polyspora Lini* Laff.), but the production of pycnidia in the case of 'Pasmo' attack is a clear and reliable distinguishing characteristic. The minute cream-coloured acervuli produced by *P. Lini* are not commonly found in the field but develop readily on the incubation of infected stems. Fig. 3 shows a typical browning lesion, while Fig. 4 shows such a lesion after incubation when acervuli have been produced in abundance.

'Pasmo' disease was first described by Spegazzini[1] in the Argentine; he named the causal organism *Phlyctœna linicoli*. Garassini[2], also working in the Argentine, renamed it *Septoria linorum*.

The disease is known to occur in the Argentine (Spegazzini[1]); United States of America (Brentzel[3,4]); Canada (Henry[5]); New Zealand (Cunningham[6]); Siberia (Natalyina[7]); Yugoslavia (Rost[8]); Rumania (Rost[9]); Germany (Wollenweber and Krüger[10,11]); Hungary (Kremmer[12]); and Peru (Rome[13]). It has not been recorded for the British Isles.

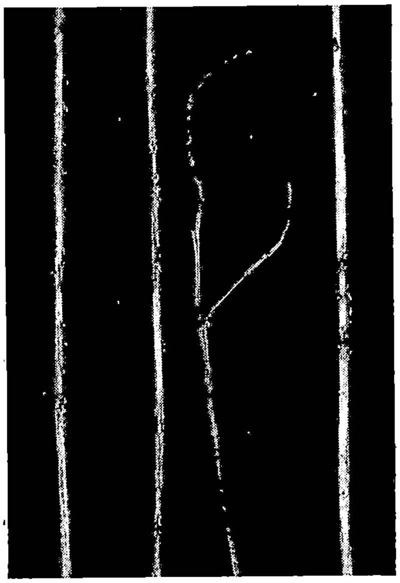
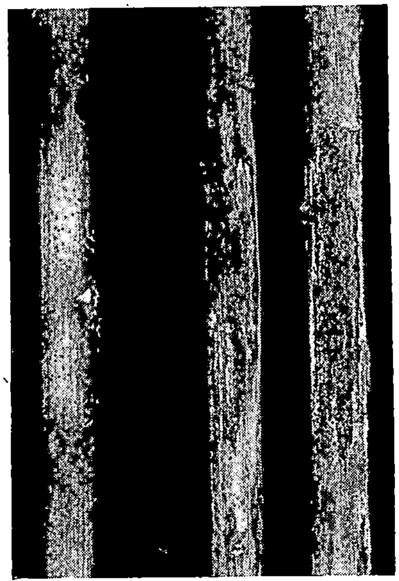


Fig. 1.



Figs. 2 3 4

Brentzel[14], who has studied the disease in the United States in considerable detail, states that pycnospores may accumulate on diseased stems and stubble, from which infection originates in the following spring. He also states that the disease is transmitted by the seed.

No evidence has yet been produced to show that 'Pasmo' can be successfully controlled by seed disinfection. Various workers have studied the resistance and susceptibility of flax varieties to attack but little information is available regarding the behaviour of those fibre varieties commonly grown in the United Kingdom. As the disease has not yet appeared in the British Isles, every effort should be made to prevent its occurrence, and the greatest care should be taken to ensure that flax seed imported into the United Kingdom is free from contamination with *S. linorum*.

JOHN COLHOUN.
ARTHUR E. MUSKETT.

Ministry of Agriculture N.I.,
Plant Disease Division,
The Queen's University,
Belfast. Jan. 20.

[1] Spegazzini, C., *An. Mus. Nac. Buenos Aires* (III), **13**, 389–390 (1911).

[2] Garassini, L. A., *Rev. Fac. Agron. La Plata*, **20**, 170–261 (1935); Abs. in *Rev. Appl. Mycol.*, **15**, 441.

[3] Brentzel, W. E., *Phytopath.*, **13**, 53–54 (1923).

[4] Brentzel, W. E., *Phytopath.*, **14**, 48–49 (1924).

[5] Henry, A. W., *Alberta Agric. Coll. Bull.*, **18** (1928); Abs. in *Rev. Appl. Mycol.*, **8**, 371.

[6] Cunningham, G. H., *N.Z. J. Agric.*, **42**, 305–306 (1931).

[7] Natalyina, O., *Plant Protection, Leningrad*, **8**, 177–183 (1931); Abs. in *Rev. Appl. Mycol.*, **11**, 45–46.

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[9] Rost, H., *Angew. Bot.*, **20**, 412–430 (1938); Abs. in *Rev. Appl. Mycol.*, **18**, 315–316.

[10] Wollenweber, H. W., *Rev. Bot. Inst. "Miguel Lillo"*, **2**, 483–494, (1938); Abs. in *Rev. Appl. Mycol.*, **18**, 111–112; Wollenweber, H. W., and Krüger, E., *NachrBl. dtsch. PflSch-Dienst.*, **18**, 11–12 (1938); Abs. in *Rev. Appl. Mycol.*, **17**, 458–459.

[11] Krüger, E., *Arb. biol. Reichsanst. Brl.*, **23**, 163–188 (1941).

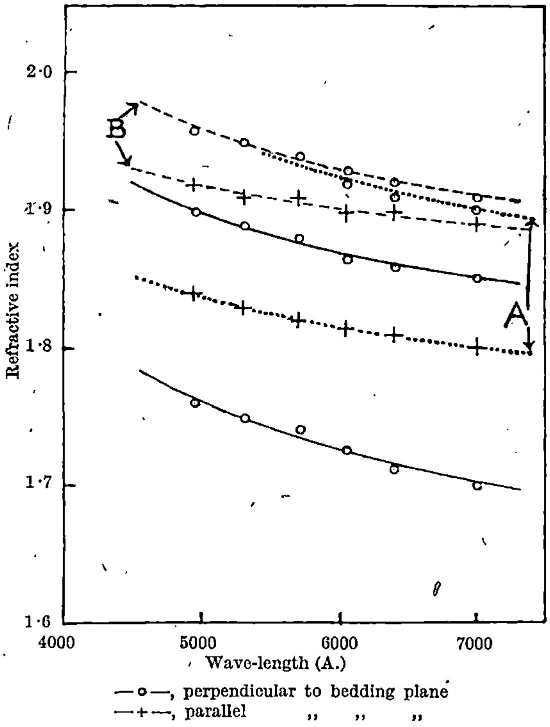
[12] Kremmer, J. A., *Bot. Kö.l.*, **38**, 62–67 (1941); Abs. in *Rev. Appl. Mycol.*, **20**, 494.

[13] Rome, *Int. Bull. Pl. Prot.*, **16**, 4M (1942); Abs. in *Rev. Appl. Mycol.*, **21**, 352.

[14] Brentzel, W. E., *J. Agric. Res.*, **32**, 25–37 (1926).

Optical Dispersion for Coals

USING the apparatus previously described[1], together with a set of Wratten Monochromat light filters Nos. 70–75, it has been possible to examine the variations of refractive index over a limited range of wave-lengths in the visible spectrum for several typical coals of varying rank. The Brewster angle was determined with each filter placed in turn before the light source, and the corresponding refractive index calculated. The determining factor limiting the accuracy of the measurements was the stability of the photo-cell amplifier. Under the most unfavourable conditions the limits of accuracy of the determination of refractive index were ±0·01. In general, the accuracy was greater than this.



Typical results are given in the accompanying figure. For two isotropic coals, the lower full-line curve is for a free-burning coal and the upper for a coking coal. For the anisotropic coals measurements were made in directions perpendicular (rings) and parallel (crosses) to the bedding plane. The curves *A* are for a Welsh anthracite and the curves *B* for a Welsh steam coal.

For all the measurements made in a direction perpendicular to the bedding plane the dispersion curves are approximately parallel; the curves for the measurements made parallel to the bedding plane are themselves parallel. But the slopes of the two sets of curves, shown respectively with rings and crosses, are markedly different. From these results it would appear that the refracting material varies but little with the rank of the coal. The difference shown in the two directions would, however, be consistent with a large-scale structure in which anisotropic units occur with preferred orientation. On such a supposition the isotropy of the lower rank coals could be obtained by completely random orientation of the same anisotropic units.

Thanks are due to Mr. J. G. Bennett, director, and Dr. D. H. Bangham, principal scientific officer, of the British Coal Utilization Research Association, for their kindness in providing the specimens.

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C. G. CANNON.
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[1] NATURE, 150, 690 (1942); and 151, 53 (1943).

Nature of Entropy

THE opening paragraph of Mr. Ian Campbell's letter[1] on the nature of entropy reads somewhat strangely to one fresh from the perusal of "Physics and Philosophy" by Sir James Jeans. Campbell argues that "a quantity which fits so completely into the mathematics of the subject must surely have some relation to the physical facts", and suggests that entropy may be regarded as analogous to momentum in mechanics. Jeans asks whether we should adopt mechanical *explanations* of Nature or the mathematical *description* of Nature, and concludes: "whether the ghostly remains of matter should be labelled as matter or as something else is mainly a question of terminology" (p. 216).

From the educational point of view, however, it is in my opinion necessary that the beginner in a scientific subject should be given at the outset some familiar mental picture. Some physical analogies of the "ghostly" quantity entropy have been described in a recent text-book[2], and it may be pointed out that before the end of last century it was customary in the Royal Naval Engineering College, Devonport, to regard entropy as 'thermal inertia', and to use rotational motion especially to illustrate thermodynamic principles, treating entropy as 'rotational inertia' (moment of inertia)[3]. In his presidential address to the Physical Society in 1911, Prof. H. L. Callendar stressed the correspondence between entropy and 'caloric'. On this view, we may regard Joseph Black's 'matter of heat' as equivalent to a mathematical function, or alternatively we are in some measure entitled to regard entropy as the modern expression for caloric.

In order to support his view as to the nature of entropy, Campbell proposes the adoption of a new scale of temperature so that "temperature may become proportional to the square root of heat energy and, in the kinetic theory, to the mean molecular velocity". I am not at all clear as to his attitude to Lord Kelvin's absolute scale of temperature—one sentence in his letter asserts, or at least suggests, that temperature "cannot be measured absolutely". On this subject there is a recent article[4] on a dynamical treatment of the elements of heat by Dr. G. Burniston Brown, in which an elementary and more directly empirical discussion is given in a form suitable for beginners. In this connexion it is worth while directing attention to the fact that momentum, depending on the first power of the velocity, is a vector quantity, having direction and sense as well as magnitude. This in itself indicates that momentum is not likely to be a suitable analogy for entropy. It should be noted that in the elementary development of Boyle's law on the basis of the kinetic theory of gases, the *square* of the velocity is involved because not only momentum enters but also the time taken by a molecule in travelling across the cubical enclosure.

The argument drawn by Campbell in favour of his suggestion from the expression $\frac{1}{2}CV^2$ for electrical energy is not convincing, and is possibly misleading. The more fundamental formula is $\frac{1}{2}QV$, where Q is quantity of electricity and V is potential. This form suggests that Callendar was right in linking entropy to "matter of heat" as the equivalent of Q, while V corresponds to temperature.

H. S. Allen.

University,
St. Andrews.
Feb. 3.

[1] Campbell, Ian D., Nature, **151**, 138 (1943).

[2] Allen and Maxwell, "Text-Book of Heat", Part 2, Chap. 30 (Macmillan, 1939). Reference may also be made to Part 1, Chap. 23, dealing with "Physical Magnitudes and their Measurement".

[3] Wheeler, S. G., "Entropy as a Tangible Conception" (Crosby Lockwood, 1921). Allen, H. S., Nature, **109**, 404 (1922).

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Newt Larvæ in Brackish Water

The statement in Miss H. Spurway's interesting observations on the above subject[1], that it is generally believed that amphibian larvæ are not found in salt or brackish water, is interesting because the brackish 'slacks' or pools between the west Lancashire coastal dunes from Ainsdale to Formby have long been inhabited by breeding specimens of the common smooth newt, common frog, common toad, and natterjack toad. The natterjack is, of course, a well-known breeding inhabitant of brackish estuary waters; many hundreds breed at Ainsdale; and I have seen its tadpoles in the tide line salt marsh at the Dee mouth between Hilbre Point and Hoylake, Cheshire, and at other estuaries.

Incidentally, mention of the natterjack toad reminds me that a species inhabits Gilbert White's famous great pond at Wolmer, although not numerously, but he did not list it in his time.

Eric Hardy.

47 Woodsorrel Road,
Liverpool, 15. Jan. 28.

[1] Nature, **151**, 109 (1943).

Water Content of Medusæ

I have read with considerable interest the recent communication from Dr. L. H. Hyman dealing with the water content of medusæ[1]. My apologies are due to Dr. Hyman for having failed to refer to his communication of 1938[2] in my own contribution to Nature[3]; but when I was doing the work and also when writing up the account it was impossible for me to get hold of the proper references, since the greater part of the library has been removed from the Laboratory at Plymouth. However, the omission shows the close agreement in our independent results.

I do not propose to discuss the merits of our different methods beyond stating that, in the *displacement method*[4], the living specimens of *Aurelia aurita* were neither rinsed in distilled water nor drained, since in this method the living specimens are not removed from their environment. According to Dr. Hyman the water content of *Aurelia aurita* in sea-water of 3·2 per cent salinity was 96 per cent, while I found it to be 96·56 per cent in sea-water of the same salinity.

Reference to the figures given by Dr. Hyman in 1938[2] will show how close the agreement is between the determinations made on both sides of the Atlantic, and one trusts that the figure 99·8 per cent for the water content as originally recorded by Gortner[5] can now be allowed to sink into obscurity and no longer find its way into current text-books either of an advanced or elementary nature. One would expect the water content to vary slightly in different specimens, but its value lies between 96 and 96·6 per cent, and it varies slightly with the salinity.

Further, in medusæ living in water of more than 3 per cent salinity, the water content ranges from 94 to 96·6 per cent. In freshwater medusæ it may be higher. 99·8 per cent is clearly an impossible figure for the water content of any animal living in ordinary sea-water, though admittedly such an animal might be composed of 99·8 per cent *sea-water*.

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Plymouth.

[1] Hyman, L. H., Nature, **151**, 140 (1943).

[2] Hyman, L. H., *Science*, **87**, 166 (1938).

[3] Lowndes, A. G., Nature, **150**, 234 (1942).

[4] Lowndes, A. G., *J. Mar. Biol. Ass.*, **25**, 555 (1942).

[5] Gortner, R. A., "Outlines of Biochemistry" (2nd Ed. John Wiley, New York, 1938), p. 276.

A Middle Pleistocene Discovery in the Anglo-Egyptian Sudan

Artefacts in type similar to the Chellean, early Acheulean, and Acheulean of the fourth stage of East Africa have been found *in situ* in ironstone gravel only 5 m. above the present flood plain on the banks of the Khor Abu Anga, a left-bank tributary which joins the Nile a kilometre downstream from the confluence of the Blue and White Niles. Late Acheulean implements and a few artefacts of Levallois type apparently associated with them have also been found on the surface; and it is hoped before long to find them *in situ* too.

Similar assemblies have also been found farther downstream on the left bank between Khor Abu Anga and the Sabaloka gorge.

These discoveries mark an important stage in the study of the history of the Nile basin. Besides showing that erosion levels had nearly reached those of the present day long before the Sebilian silts were deposited below Wadi Halfa, and that a pre-Sebilian lake extending as far as the Sabaloka hills is most improbable, they indicate the way by which further study will yield a more complete view of the history of the two Niles, and will link up the succession of events in East Africa and the Belgian Congo with those in Egypt and the Mediterranean region generally.

Evidence has also been found in favour of regarding the ironstone gravels of the district as of sedimentary detrital origin, derived from the local Nubian series. The previous view[1] that these were lateritic '*marram*' and indicated a comparatively late 'lateritic' climate is without foundation[2], as no trace of general 'lateritization' of the included boulders or artefacts can be found, nor is there any lateritization of subjacent deposits, whether rock (Nubian series) or gravels and sands.

G. Andrew.
A. J. Arkell.

Office of Commissioner for Archæology
and Anthropology,
P.O. Box 178,
Khartoum. Nov. 11.

[1] Sandford, *Quart. J. Geol. Soc.*, **91**, 367 (1935).

[2] cf. Edmonds, *Geol. Mag.*, **79**, 29 (1942).

EVOLUTION OF WIRE TELEPHONY

GEORGE H. GRAY, writing in *Electrical Communication* (20, No. 4; 1942) gives a brief historical review of the progress achieved in telephone wire transmission systems since the early days of the telephone, followed by a discussion of the important economic implications of the newer broad band systems, the 12-channel carrier and coaxial cable. The review is divided into four periods. Plant additions permitted advances during each period in at least three of the following respects: conversation distance, transmission channels obtainable from a pair of conductors, frequency band transmitted and, hence, improved quality and naturalness of conversation, and reliability of service.

The first period, dating from 1876, ended about 1900. Although conversation then was virtually still limited to one per pair of wires, reliability of service and transmitted quality had been improved and the transmitting distance increased considerably, due largely to the use of copper instead of iron wire, better insulators, improved line construction and carefully designed transposition schemes. These changes involved no additions to the inside plant and no increased complications in the outside plant other than the necessity for properly maintaining the transpositions. Using 4·19 mm. copper wire, conversation under favourable conditions was possible by the end of this period over distances of nearly 1,600 km.

The second period, from 1900 to about 1915, saw the introduction of phantom circuits, loading coils and quadded toll cable. These changes resulted in a 50 per cent increase in the circuit capacity of a pair of wires and in slightly more than doubling the transmitting distance of open-wire circuits. The use of underground toll cable, of course, improved the reliability of service. Loading, however, limited the frequency band which could be transmitted, and in some cases this was confined to frequencies below approximately 1,800 cycles, affecting the quality of the transmission accordingly.

The introduction of loading coils also reduced the speed of transmission, thus bringing about potential difficulties from transient and echo effects; this was not particularly objectionable at the time as the circuits involved were comparatively short. The inside plant was made slightly more complex by the phantom repeating coils, and the loading made necessary certain precautions in the maintenance of the outside plant. In general, however, this period added little to plant complexity.

The third period, 1915–37, included the introduction of some radically different and very important types of plant, such as the vacuum tube repeater, the four-wire circuit, one- and three-channel carrier systems, and radio links.

During the last few years of the second period, interesting service results had been obtained with 'mechanical' repeaters, consisting essentially of combination microphones and telephone receivers, but this was abandoned soon after the advent of the vacuum tube repeater. The latter at once more than doubled the transmitting distance of open wire circuits and, by making possible the removal of open wire loading, permitted the transmission of an increased band width. In cable circuits, repeaters permitted a reduction in the weight of loading and hence an increase in the band width and speed of propagation. The four-wire circuit greatly increased the transmitting range for cable. The three-channel carrier made it possible to obtain nine circuits from an open wire phantom group where only three could be obtained before. By combining transoceanic radio links with land circuits, the transmitting range was increased to such an extent that a conversation around the world was held in 1935 over the route New York–London–Amsterdam–Java–San Francisco –New York, approximately 36,000 km. These advances were not obtained without an increase in the complexity of the plant. It became necessary to maintain repeaters, carrier terminal equipment, radio terminal equipment, special transposition schemes, etc., but, on the whole, no very serious difficulties were encountered. This was due, in no small measure, to special plant personnel training courses conducted at appropriate intervals.

Thus, vacuum tube repeaters and three-channel open wire carrier systems made possible a practically unlimited increase in transmission range and an improvement in transmission quality. Their introduction, moreover, influenced toll-rate decreases appreciably, although outside plant expenditures remained a fairly large factor in the cost of furnishing toll telephone service. Consequently considerable attention was devoted to possibilities of further reductions in outside plant costs.

With near-zero-equivalent circuits already available on conductors approaching the minimum size imposed by mechanical limitations, the most promising solution seemed to be a further increase in the number of circuits obtainable per pair of wires. This involved an increase in the frequency band transmitted and, unfortunately, greater transmission losses and cross-talk due to the application of higher frequencies.

The negative feedback repeater, special transposition schemes for open wire lines, the separation of the 'go' and 'return' conductors in cables, special entrance cables, very careful balancing of all circuits, improved filters, dry metallic modulators, and demodulators, and many other developments made possible the application of higher frequencies to existing types of plant and paved the way for the next period in the history of wire transmission systems.

The fourth period, now well initiated, commenced about 1937 and may be designated as the 'broad band' period of wire transmission. The more important developments include the twelve-channel open wire carrier, the twelve-channel cable carrier and the coaxial cable. Although definite predictions would be somewhat premature, present indications are that progress during this period will exceed even that of the previous period.

Loading performed an important service in improving transmission, but the necessity for transmitting a wider frequency range at higher speeds has now brought about its abandonment for the highest grade of circuits in both open wire and cable.

In the case of twelve-channel systems, it might be thought that elimination of loading and the necessity for frequencies up to 60 kc./s. would prevent their commercial application. Actually, however, attenuation of 1·29 mm. conductors in twelve-channel cable systems is about 2·6 db./mile at 60 kc./s., a value which is quite admissible since it is practicable in this case to work the channels at an attenuation of approximately 60 db. per section with repeaters spaced at intervals of about 35 km. Development of these repeaters has progressed to a point where about two out of every three repeater stations generally can be operated unattended.

The reasons for this high permissible attenuation are very low outside interference at high frequencies and the use of separate cables for the two directions, or, alternatively, a single copper-screened cable to reduce interference between the go-and-return channels. The limit of amplification, or attenuation, is determined by the signal-noise ratio; low outside interference and low cross-talk result in decreased noise. Speech or transmission signals, therefore, may be correspondingly reduced; that is, very high level differences between the beginning and end of a cable section are permissible.

An inherent advantage of twelve-channel systems, highly significant from an economic point of view, results from the importance of installing cables sufficiently large to provide adequately for future growth. Since cable cost represents the greater part of the total outlay for a non-carrier system, the initial investment in cables is ordinarily great, and full realization of returns must be deferred until they are worked at full capacity. In twelve-channel systems the initial investment, on the contrary, is relatively low, and terminal equipment can be added when required; moreover, a better balance between outlay and revenue can be attained over the entire period of use.

It should be emphasized that no attempt was made to reduce the width of the frequency band when the number of channels was increased. Long experience and extensive research have demonstrated the importance of transmitting a relatively wide frequency band. A wide band width, moreover, makes it possible to reduce the transmission level, especially if the noise is low, while if the transmission loss in a long-distance link is reduced to zero, the total allowable losses can be concentrated in the local networks with considerable decrease in their cost. Further, this loss may be increased by several decibels for the same overall effective transmission if the width of the transmitted frequency band is adequately increased. To derive the full benefit from the widening of the band, the subscribers' apparatus—transmitter and receiver—must be capable of producing and reproducing this band; such apparatus has been developed and introduced into commercial use.

The propagation velocity over twelve-channel cable systems is instantaneous for all practical purposes. Even on the longest lines, therefore, speech quality is not appreciably diminished by echoes or other phenomena due to low propagation speed, and therefore lines may be interconnected at will.

Because of the advantages of the twelve-channel carrier cable system, the General Post Office in Great Britain immediately adopted it for its principal toll networks, and the first of such systems was installed in England even before the close of 1936. Shortly thereafter systems were installed in other countries, including the United States, France, Rumania, Sweden, Finland, Holland and Belgium.

For use where very large numbers of telephone circuits were needed and for television, which requires cables capable of transmitting a frequency band of at least 2 mc./s., consideration was given to the application of coaxial cables, the speech channels of which are counted in hundreds. Even for cables of small diameter, frequencies of the order of several megacycles per second can be handled and, since telephone channels are spaced at 4 kc./s., several hundred voice channels can readily be made available.

In Europe, coaxial cables have been laid in Great Britain, France and Germany. In the United States, a 150 km. cable containing two 6·7 mm. coaxial lines has been installed between New York and Philadelphia and another four-line 300 km. coaxial cable recently was placed in commercial telephone service between Stevens Point, Wisconsin, and Minneapolis, Minnesota.

The external conductor, at least above 50 kc./s., serves as a very effective screen against external interference. Hence, very low signal levels, permitting attenuation of 45–60 db. per section between repeaters, are acceptable. In a cable of 6·7 mm. internal diameter, intervals of about 8 km. between repeaters are thus admissible with a frequency band extending up to 3 mc./s.

In coaxial cable systems, the total attenuation for a long line is very high; for example, a 1,000 km. coaxial cable (6·7 mm.), capable of transmitting a frequency band suitable for 300 telephone channels, would have an attenuation of about 4,500 db. Since reception levels must be maintained within about ±1 db., repeaters must have a high degree of stability, and the net result is a permissible tolerance of about 0·01 db. per repeater. Furthermore, from the point of view of distortion and noise, these repeaters must meet stringent requirements. A very satisfactory solution is provided by the application of feedback repeaters.

The attenuation of the cable itself, either of the coaxial or twelve-channel type, varies with temperature, so that very long circuits, especially if in aerial cables, necessitate the introduction of compensation devices. For underground cables, manual compensation may be used; for aerial cables, automatic compensation is required due to more rapid temperature fluctuations. Recently a simplified regulating method using devices known as 'thermistors', the resistance of which varies with temperature in the required manner, has been developed and is expected largely to replace the former rather complicated mechanism.

Although the new transmission systems available in this fourth period of development make use of apparatus which at first glance may appear complicated, there seems to be no reason, based on extensive experience to date, to expect any more serious reaction from their application than was encountered with innovations during the other three periods.

The coaxial repeaters, especially, do not require auxiliary equipment. Furthermore, they may be installed in small, simple structures, or be enclosed in metallic housings placed on poles or in underground chambers. The relatively large number of repeaters necessary is no cause for concern. Experience has demonstrated conclusively that the manufacture of repeaters involving minimum risk of breakdown is a practical proposition; in addition, arrangements are such that either an individual repeater or a complete cable and repeater section may be replaced automatically by a reserve repeater or a complete reserve section.

The new systems represent a most important advance in long-distance communication engineering. Moreover, their development has progressed to the point where they can be considered commercially stabilized to the extent that no radical modification in the structure of cables, repeaters or terminal equipment is to be anticipated. It therefore seems evident that such broad band systems can confidently be taken as the basis for studies of new networks, affording possibilities of rate reductions and of effecting an extraordinary development in high-quality long-distance telephone communications. Further, their advent makes practical, in many instances, provision for the introduction of television networks on an international scale.

Advances during the first two periods were effected largely with material and apparatus placed in the field, that is, 'outside plant'; those of the third period depended largely on central office equipment. While an important element in progress during the fourth period doubtless must be credited to central office equipment, such as the terminal apparatus for the coaxial and twelve-channel systems, it appears that a new essential factor will be the adaptation of apparatus heretofore regarded as central office equipment to utilization in the field. This new apparatus, as previously indicated, has been embodied in unattended repeater stations.

ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF ALLIED COUNTRIES

GENERAL MEETING

THE Association of University Professors and Lecturers of Allied Countries in Great Britain marked its third general meeting with a whole-day session on December 16. The Association, which now comprises 230 members, works through twelve sections (see NATURE, December 12, p. 692), most of which had separate meetings, followed by a general meeting of all members. At this general reunion, reports were presented by the chairmen of groups of sections, and general recommendations made. Thus the deliberations of the individual sections were brought together, to present an inter-Allied view on matters in different domains of actual knowledge. Complete liberty of academic thought and spirit, with such freedom of speech as would be impossible in the countries of continental Europe, characterized the proceedings.

The main points of the aims and work accomplished by the groups of sections were as follow:

Arts: Law, economics, humanities and history, such as studies of comparative law; the position of economic science in the different countries; establishment of a scientific basis for economic planning; the possibility of reaching an agreement on the question of general history; and considerations relating to an international language.

Science: Inter-Allied collaboration for the establishment of an international academy of medicine; the establishment of an international body of information, and the co-ordination of inventions and scientific discoveries in general; an international research centre; collaboration with the Leith-Ross Committee; the establishment of liaisons with British organizations which are studying the planning and reconstruction of Europe; the examination of problems concerning the moral and material sustenance of scientific men in comparison with the manual worker.

General: Dealing with general subjects and with questions of general interest for university men; for example, contacts between British and foreign scholars in Great Britain during the War; the promotion of international collaboration after the War; reconstruction and planning of science and learning in the occupied countries, and the problems of the re-education of youth after the War in Allied and enemy countries.

Prof. R. Douglas Laurie, honorary general secretary of the Association of University Teachers, announced that all members of the Association of University Professors and Lecturers of Allied Countries were invited to become honorary members of the Association of University Teachers. This will lead to closer working and social unity between British and Allied professors and lecturers.

In the course of an address by the president of the Association, Prof. S. Glaser (Poland), the various steps were mentioned which the Association has so far been able to make to promote the necessary collaboration between scientific workers and other scholars of the Allied countries. The reconstruction of moral values as well as the rebuilding of institutions of all categories constitutes, he said, one of the aims towards which the Association is exerting its efforts. This is being carried out, so far as possible, with a profound sense, both spiritual as well as cultural, of the importance of European society as a whole after the War.

It was decided at the general meeting, among other matters, that a conference on a fairly large scale on education should be arranged for the early spring 1943, and a sub-committee under the chairmanship of Sir Alfred Zimmern (Oxford) has been appointed for this purpose.

In NATURE of December 12, a list was given of the general officers and chairmen of sections of the Association. The following can now be added to the list. Section 3: Reconstruction of science and learning in the occupied countries (*Chairman:* Mr. Willard Connely). Section 9: Medicine as distinct from general science (*Chairman:* Dr. Jean-Edouard Bigwood). Section 10:, Technical Science and Engineering, has been placed in Section 6 (Science).

Thanks to the efforts of the Association, very useful collaboration between members in the field of learning and scientific research is being established among the various professors and lecturers of the Allied countries. It provides an opportunity of establishing unity in the true sense of the word, namely, with intellectual and moral solidarity; a fact the importance of which will be appreciated by scientific men and other scholars of the Allied countries, wherever their interests in the plans and problems of to-morrow may lie.

THE WAIRARAPA (NEW ZEALAND) EARTHQUAKE OF JUNE 24, 1942

A PRELIMINARY report on some of the seismological aspects of the Wairarapa earthquake of June 24, 1942, has been issued by the Department of Scientific and Industrial Research, New Zealand (*Dominion Observatory Bull. S*-66, Wellington, New Zealand, September, 1942).

Following a rather strong fore-shock at 8.14 p.m. on June 24, the major shock occurred without further warning at 11h. 16·5m. p.m. (New Zealand Daylight Saving Time). Considerable damage to old or poorly constructed buildings occurred at Masterton, where the intensity appeared to be 8+ on the Rossi-Forel scale. There were no fatal casualties, though minor injuries were caused by falling debris. Intensity 8 on the Rossi-Forel scale was attained over a large part of Wairarapa, and the intensity in Wellington City was between 7 and 8. There was evidence of surface faulting at a point 8 miles east of Masterton, and running from a point about 10 miles north-north-east of this point to about 30 miles south of it.

The area over which the shock was felt extended from about Auckland in the north to Dunedin and Queenstown in the south, the latter place being 470 miles from the epicentre. The epicentre, determined from seismographic evidence and supported by field evidence, was near lat. 40·9° S., long. 175·8° E. The focal depth was probably normal. Earthquake sounds, usually low rumblings, and luminous phenomena, usually blue or green flashes, were reported from numerous places in both islands.

Up to June 30, 418 aftershocks were recorded by the seismographs at Wellington, 300 of these being within 24 hours after the main shock. None of these shocks was a large one, but on August 2 at 00h. 34m. a.m. N.Z.D.S.T. a shock nearly as severe as the initial one occurred. Some further damage was caused, chiefly to buildings previously damaged, and occasionally to buildings repaired after the first shock in which the mortar had not had time to harden.

The Wairarapa district has been shaken previously by earthquakes on March 5, 1934, August 6, 1917, April 12, 1913, August 4, 1904, and in 1855, epicentres not always being in the same place.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk are open to the public*)

Tuesday, February 23

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. I. Zollschan: "How to Combat Racial Philosophy".

Royal College of Physicians (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Dr. S. A. Henry: "The Health of the Factory Worker in War Time" (Milroy Lectures, 1).

Chadwick Public Lecture (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. M. Greenwood, F.R.S.: "Social and Industrial Environment and Disease".*

Manchester Literary and Philosophical Society (in Room No. 7, The University, Manchester), at 5 p.m.—Dr. J. H. Shaxby: "The Human Senses, especially Sight and Colour Vision".

Institution of Civil Engineers (Railway Engineering Division) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. S. Quartermaine: "Railway Construction in Great Britain under War Conditions".

Wednesday, February 24

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. P. E. Cross: "Agriculture To-day and To-morrow", 5: "Extension of Market Gardening into Agriculture".

Thursday, February 25

British Society for International Bibliography (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Annual General Meeting. Mr. E. Lancaster-Jones: "The Operation of a Microfilm Service". Symposium on "The Classification of Maps and Plans for Territorial Planning" (to be opened by Mr. E. Carter).

Royal College of Physicians (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Dr. S. A. Henry: "The Health of the Factory Worker in War Time" (Milroy Lectures, 2).

Friday, February 26

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. L. P. Abercrombie: "The Inter-Action between Town and Country Planning".

Chemical Society (in the Lecture Theatre of the Chemistry Department, University College of North Wales, Bangor), at 5.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "Some Aspects of the Chemical Constitution of Milk Fats".

Chemical Society (Joint Meeting with the University Chemical Society) (in the Chemical Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. M. Gulland: "Aspects of Nucleotide Chemistry" (Tilden Lecture).

Saturday, February 27

Malacological Society (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting and Commemoration of the 50th Anniversary of the Society's Foundation.

Light Railway Transport League (at Fred Tallant Hall, Room J, Drummond Street, London, N.W.1), at 3 p.m.—Dr. Hugh Nicol: "A Scientist Looks at Transport".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Master to teach Mathematics, with some Physics or Chemistry, in the Sheffield Junior Technical School for Boys—The Director of Education, Education Office, Leopold Street, Sheffield 1 (February 24).

Lecturer in Electrical Engineering—The Clerk to the Governors, Heanor Mining and Technical School, 30 Mansfield Road, Heanor, Derbyshire (February 24).

Teacher (man) of Physics in the Junior Technical School—The Principal, Technical College, Church Street, Barnsley (February 26).

Chair of Mining—The Secretary, The University, Edmund Street, Birmingham 3 (March 1).

Instructor in Beekeeping—The Education Officer, County Hall, Wakefield (March 1).

Assistant with knowledge of Russian, German and other European Languages—The Deputy Director, Imperial Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9 (March 5).

Master to teach Mathematics and Science in the new Junior Technical School Building Course for Boys, Bingley Technical School—The Divisional Education Officer, Education Offices, Bingley, Yorks. (March 7).

Sir Dorab Tata Reader in Pharmaceutical Chemistry in the Department of Chemical Technology—The Registrar, University of Bombay, Bombay, India (April 15).

Teacher of Engineering Workshop Practice and General Engineering Subjects in the Burton-on-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-on-Trent.

Research Assistant—The Director, Research Association of British Flour-Millers, Old London Road, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Selected Papers from the Royal Cancer Hospital (Free) and the Chester Beatty Research Institute. (Published by order of the Governors of the Royal Cancer Hospital (Free), London.) Vol. 1, 1935–1939. Pp. xii+484. (London: Royal Cancer Hospital (Free).) 16*s*. [201

Thorley's Farmer's Diary and Almanack, 1943. Pp. 48. (London: Joseph Thorley, Ltd.) 6*d*. [201

Other Countries

Indian Forest Bulletin No. 112: Interim Report on the Manufacture of Kraft Paper from Bamboos. By M. P. Bhargava and Chattar Singh. Pp. v+13. (Delhi: Manager of Publications.) 7 annas: 8*d*. [81

Canada: Department of Mines and Resources, Mines and Geology Branch: Geological Survey. Paper 42–7: Preliminary Map, Takla, British Columbia. By J. E. Armstrong. 10 cents. Paper 42–11: The Pinchi Lake Mercury Belt, British Columbia. By J. E. Armstrong. Pp. 18+map. 10 cents. Paper 42–12: Preliminary Map, Vassan-Dubuisson, Abitibi County, Quebec. By G. W. H. Norman. 10 cents. Paper 42–13: Preliminary Map, Beresford Lake, Manitoba. By C. H. Stockwell. 10 cents. Paper 42–14: Preliminary Map, Gem Lake, Manitoba By C. H. Stockwell. 10 cents. (Ottawa: King's Printer.) [81

Reports of the Biochemical Research Foundation of the Franklin Institute. Vol. 6, 1940–1941. (Newark, Del.: Biochemical Research Fund.) [151

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 146: An Analysis of the Outbreaks of the Australian Plague Locust (*Chortoicetes terminifera* Walk) during the Seasons 1937–38 and 1938–39. By Dr. K. H. L. Key. Pp. 88. Pamphlet No. 110: The Main Virus Diseases of the Potato in Victoria. By Dr. J. G. Bald and A. T. Pugsley. Pp. 40+4 plates. Pamphlet No. 114: Plant Introduction. 1: A Review, with Notes on Outstanding Species, by Dr. A. McTaggart; 2: Preliminary Selection and Evaluation of Pasture Species at Lawes (Queensland), by T. B. Paltridge. Pp. 30. (Melbourne: Government Printer.) [201

Faculdade de Ciências da Universidade do Pôrto: Instituto de Antropologia. Da Raca e do Espérito. Por Prof. A. A. Mendes Corrêa. Pp. viii+306. A Escola Antropológica Portuense. Por Prof. A. A. Mendes Corrêa. Pp. 60+19 plates. (Pôrto: Universidade do Pôrto.) [201

Asociación Espanola para el Progreso de las Ciencias. Perspectivas duma Antropologia Citológica. Por el Dr. A. A. Mendes Corrêa. Pp. 16. (Madrid Asociación Espanola para el Progreso de las Ciencias.) [201

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CENTENARY OF THE HOUSE OF MACMILLAN

THE House of Macmillan, as a publishing firm, is a hundred years old. Daniel and Alexander Macmillan founded the firm in 1843, and their first two books, A. R. Craig's "The Philosophy of Training" and W. H. Miller's "The Three Questions: What am I? Whence came I? Whither do I Go?" were published during that year.

Birth and Growing Pains

Daniel and Alexander were both sons of Scottish peasants. Daniel was born in the island of Arran on September 13, 1813; but the family migrated to Irvine, on the opposite coast, when Daniel was three years old. Daniel eventually went to Glasgow where he made several faithful friends, such as Dr. George Wilson, the technologist and author of the "Five Gateways of Knowledge", and Mr. J. MacLehose, who eventually became Glasgow's leading bookseller and publisher, and whose firm to-day is the Glasgow University Press, with whom the House of Macmillan still enjoys happy collaboration. Indeed, Daniel was very fortunate in his friends, and the fruits of such friendships are still being garnered by the present-day firm and the public it serves so well.

In 1833, Daniel came to London. He joined the firm of Simpkin Marshall, but was not content there. He spent some time considering going to Cambridge after failing to obtain a post with the publishing firm of Longman. It is just as well at this stage to examine the character of one of the two most important founders of this great firm. Before leaving London, Daniel decided to see the sights; his letters to various relatives and friends bring out the character of the man. For example, in a letter to his brother William, written on September 30, 1833, he says:

> "The top of St. Paul's. What a sight. To see all London, even its highest spires, under one's feet, to think of the many thousand souls that are busy in that mighty mass of brick; the number of sailors who are now busy among yon forestry of masts; the numbers who are dying; the numbers who are just entering upon life. To think of those who are enduring pain, and those who are enjoying pleasure; of the villains and the saints; the active and the indolent: the virtuous and the vicious: the pious and the profane: the prodigiously rich and the miserably poor: the noble and the mean, who inhabit or infest that marvellous and mighty place, improving or injuring its morals, saving or destroying its souls. It is awful beyond description. I can hardly bear it."

Daniel Macmillan was a man who admitted to and performed a mission in life, a man who recognized a debt to society—a very practical sociologist. And like all such individuals, he was impetuous beyond belief. His impetuosity remained with him to the day of his death on June 27, 1857, when, as Thomas Hughes, author of "Tom Brown's School Days", wrote of him: "In a few hours the impetuous spirit was at rest". Here we had a man who, in his impetuosity, was striving to give something to the world, and who, therefore, like his brother Alexander, did not miss his greatest chances in life by wasting time calculating what he himself was to get out of it. Those who, under the cloak of service to humanity, are really seeking self-aggrandizement (and such exist even in the scientific world) might with profit study the lives of such people as the founders of the House of Macmillan.

Cambridge Days

At Cambridge, Daniel Macmillan joined Mr. Johnson, a bookseller, but three years afterwards, in 1837, he left again, having made many friends, some of them rising men in the University. Later, he came to London and entered Messrs. Seeley of Fleet Street, where he was joined by his brother Alexander in 1839. Alexander was five years younger than Daniel, and was a village schoolmaster near Paisley when he left Scotland for London.

After working very hard against considerable poverty, the two brothers, in February 1843, were able to claim independence and they opened a shop in Aldersgate Street, London, with little or no capital to back them up. However, on the advice of Archdeacon Hare, whose reputation at Cambridge was then at its height, the Macmillan brothers transferred their business to Cambridge towards the end of 1843, and there, until Hare's death on January 23, 1855, both brothers, especially Daniel, came under the influence of the Archdeacon.

Daniel married Francis Orridge, daughter of a Cambridge pharmaceutical chemist, on September 4, 1850. Their first boy, Frederick (afterwards Sir Frederick), was born in 1851, and the second, Maurice, in 1853.

The Cambridge book-selling business of the Macmillans flourished in spite of Daniel's ill-health and the firm's lack of sound financial backing. The success was probably due initially to the peculiar experience and whole sympathies of Daniel, and to the enthusiastic support of Archdeacon Hare. Both brothers established good relations with the University undergraduates. As one of their earliest customers wrote:

> "When the Macmillans first established their shop in the heart of the University, on a well-chosen site opposite the gates of the Senate House, the undergraduates felt that with men hardly older than ourselves there was opened to us a new sphere of interest. They were the first booksellers whom I, for my own part, had ever known to take an enthusiastic interest in their business and to have a literary insight below the binding of their books."

Thus the Macmillans gained and developed the confidence of the university men—undergraduates and authorities alike. Writing to Thomas Hughes of Daniel Macmillan, the then Headmaster of Uppingham said:

> "He stands out in my memory perhaps the most distinct personality of my early manhood—the embodiment of gentle, thoughtful power, which attracted one exceedingly, and lives with me still."

Among the regular visitors to the Macmillans' shop were the 'Olympian Thompson', W. G. Clerk, the mathematicians Todhunter and Barnard Smith, and the three great Cambridge scholars, Westcott, Lightfoot and Hort. Alexander was also a close friend of Clerk Maxwell.

Congratulations and encouragement were now pouring in on the young brothers, so that within the first year at Cambridge, the possibilities of a publishing business of their own crept into Daniel's mind, though the smallness of the capital of the bookseller's shop kept the brothers in constant anxiety. However, after bringing in a succession of partners, capital increased, and in 1845, Daniel was at last convinced that the chance of growth for the business lay in the direction of publishing more than bookselling. The advantages which their position at Cambridge, a great literary centre, gave them had become more and more apparent. Here was a mine, hitherto almost unworked, for the best book-producing power, especially of educational books.

Thus Daniel and Alexander Macmillan, although they had to date published only a few works, turned seriously to publishing, and from the very first established and maintained contact with the best writers and editors, especially among the Cambridge men. The close liaison which they developed between themselves and their authors may be illustrated by the following quotation from a letter written by Daniel Macmillan to Charles Kingsley, commenting on the latter's sketch of his projected "Westward Ho !"

> "We are greatly taken with all you tell us about the plan and character of your novel. Of course you will not adopt that pseudo-antique manner in which *Esmond, Mary Powell*, &c., &c., are written. That style is now getting a bore. The free march of your own style will be much more Elizabethan in manner and tone than any you can assume. We feel sure it will be a right brave and noble book, and do good to England."

A further comment he wrote on Kingsley's proposed "Wonders of the Sea Shore" is so amusing as to deserve quotation here:

> "We don't think it will pay to give copies to the country papers. The rascals sell and lend books, and do more harm than good."

During the first period of publishing, lasting for several decades, most of the Macmillan books were in keeping with the then public and academic taste on theological or moral philosophical themes.

Daniel Macmillan died at the very early age of forty-six on June 27, 1857, leaving three sons and one daughter. Two of his sons, Frederick and Maurice eventually became directors of the firm. It was therefore left to his older brother, Alexander, to develop much of the educational side of the Macmillan business and to sow the seed which eventually grew and ripened into the products which academic and other reading men know so well to-day. Alexander's devotion to F. D. Maurice, the leading Cambridge divine, Archdeacon Hare, Hort, Charles Kingsley, and his affection for Matthew Arnold, John Morley, T. H. Huxley and W. K. Clifford were great assets in helping him to keep in touch with all branches of scholarship in those days.

He, too, like his brother, though deeply religious, was far from being intolerant. This is well illustrated in a letter he wrote to Tennyson, in which, referring to Darwin's "Origin of Species", which had just been published, he said:

> "I wish someone could bring out the other side. *But surely the scientific men ought on no account to be hindered from saying what they find are facts*" [italics ours].

The discussions on Darwin's recent publication at one of the Macmillan famous Thursday Evenings held at the Covent Garden premises must have been full of inspiration and have given much food for thought, for such worthies as Huxley, Kingsley, Maurice, Hughes and Masson contributed to them.

Alexander died on January 26, 1896. His son, George, eventually became another director of the firm.

Return to London

In 1858, a London branch of the firm had been opened in Henrietta Street, Covent Garden. Then, the remarkable expansion of the business had made it imperative to move the headquarters to London in 1863, and the firm remained in Covent Garden until 1897, when it built its own fine premises in St. Martin's Street, which it still occupies.

Tracing the period from that date to the present day, it is interesting to note that family continuity in the direction of the business has been maintained to a considerable degree. Sir Frederick Macmillan and Mr. Maurice Macmillan, sons of Daniel, and Mr. George Macmillan, son of Alexander, actively directed the firm until their deaths in close succession to each other in 1936. Since then, Mr. Daniel and the Right Hon. Harold Macmillan, sons of Maurice, and Mr. William Macmillan, son of George, have been chairman, vice-chairman and director respectively.

To-day the influence of the House of Macmillan has extended itself to all parts of the world where books are published or eventually find their way. The Macmillan Company of New York, originally founded by the British firm in 1869, has developed into one of the most important publishing houses in the United States. Although now under independent management, it works in close co-operation with the British company. The Macmillan Company of Canada was established in Toronto in 1906, and now occupies a leading position in the Canadian publishing world. The parent British firm has connexions all over the world, publishes books in many different languages, and has three offices in India and one in Australia.

The modern reader of general literature associates the name of Macmillan with such distinguished authors as Rudyard Kipling, Lewis Carroll, Thomas Hardy, W. B. Yeats, Hugh Walpole, Rebecca West, James Stephens, Pearl Buck, James Hilton, Osbert Sitwell, Mazo de la Roche, to name only a few of the best-known figures in their list. Among the well-known periodicals it publishes are the *Economic Journal*, the *Round Table*, the *Nursing Times* and NATURE.

The firm's activities, however, cover the whole range of literature, history, philosophy, economics and sociology, as well as scientific and technical treatises and all classes of educational books from those suitable for nursery schools to well-known university texts.

Readers of NATURE will be especially interested in the Macmillan scientific and educational publications —those solid, dependable works, the most successful of which go through edition after edition, and, unlike most fiction which is of an ephemeral nature, remain on the catalogue for decades. These scientific, educational and other works of scholarship have proved to be the backbone of the firm, and a brief review of the development of Macmillans along these lines may give some insight into the *raison d'être* of the present firm as one of the leading British publishers of educational books and periodicals.

"NATURE"

The idea of a weekly journal of science began in 1868 with discussions between Sir Norman Lockyer, the astronomer and spectroscopist, and his friends, among whom were Alexander Macmillan. Lockyer was assured of the support of T. H. Huxley, Tyndall and practically all the other leading workers in science of the time. Alexander Macmillan enlisted the support of Sir Joseph Hooker and other of his scientific friends; but much of the initial success was due to Alexander Macmillan himself, of whom Sir Norman Lockyer once wrote:

> "It was in consequence of his sympathy and enthusiastic assistance that the journal started. He was unwavering in his support of the belief that British science would be advanced by a periodical devoted to its interest. . . . It was the hope that a more favourable condition for the advancement of science might be thereby secured that led Mr. Alexander Macmillan to enter warmly into the establishment of *Nature* in 1869."

In this connexion we might quote part of a letter written by Alexander Macmillan to Sir William Thomson (afterwards Lord Kelvin):

> "Lockyer is going to start a weekly Journal of Science, which we are to publish. It is meant to be popular in part, but also sound, and part devoted specifically to scientific men and their intercourse with each other. Huxley, Balfour Stewart, Wilkinson, Tyndall, Roscoe and almost everyone who is about London have given him their names, and he very greatly wishes yours, as among those who promise support. May I tell him you consent ?"

The launching of NATURE is chronicled in a letter to the Glasgow bookseller, MacLehose, written on November 3, 1869 :

> "*Nature* is to be published on Thursday in London at 2.30. . . . Lockyer was peremptory that our publication day should indicate the point to which our information is brought up. The fallacy of a Saturday publication with a Thursday actual information he does not think right. . . . We start with 18 pp. of advertisements. . . . I think it will look nice."

In the complete context of this letter it is worth noting that Sir Norman Lockyer had an absolutely free hand in reviewing books published by the firm of Macmillan itself, and never hesitated to criticize them adversely if he thought they deserved it. This absolute and complete freedom of policy has been extended to the editors of NATURE from that day to this.

In 1919, Sir Richard Gregory succeeded Sir Norman Lockyer in the editorial chair of NATURE. During his long period of editorship the journal made considerable progress, and its influence in the world of science has gradually become stronger and more secure. To-day it is the leading journal of science. In 1938, Sir Richard Gregory was succeeded jointly by Mr. A. J. V. Gale and Mr. L. J. F. Brimble. The extent to which NATURE has now grown, not only in scientific but also sociological influence, must be left to the opinion of its readers.

One thing, however, we think that readers of NATURE should know is the great debt which they owe to the publishers. NATURE was initially launched and is still being published almost solely for the advancement of science, in spite of the fact that it is privately owned by a business firm. The present editors feel impelled to put on record their gratitude to the present directors of the House of Macmillan for the entirely free hand given them in guiding the policy of NATURE and in deciding what shall and what shall not be published. To-day, as much as ever, if NATURE feels that in the interests of science and culture, any book, whether published by Macmillans or not, should receive adverse criticism, then it gets it. If NATURE desires to follow a certain policy where science is concerned, whether it be against or in support of other authorities, even the Government, then her policy is pursued relentlessly, yet, we hope, with tolerance. The directors never interfere with policy. Rather do they encourage the journal in all manner of ways, some of which have not received the recognition in the past that they deserved. In fact, it is quite possible that had the former directors not been prepared in the interest of scientific development to publish NATURE for several decades at a financial loss, NATURE, as we now know it, might not be in existence.

To-day, financial problems do not exist, and the considerable help given during the present very difficult times (especially of paper shortage and other exigencies of war) by the directors and their staffs certainly relieve the present editors of a considerable amount of care, and thus contribute in no small way towards the advancement of science in general and the success of NATURE in particular.

Educational Books

Text-books and works of scholarship which have emanated from the House of Macmillan have been legion. There has never been anything shoddy or cheap about those publications, for the directors invariably choose their authors with scrupulous care, and having once chosen them give them every possible help towards the best production that can be obtained from a first-class author working in complete harmony with a first-class publisher. In fact, though it is obvious that some works of scholarship, especially the very advanced, can never prove to be paying propositions, that has not deterred the directors from publishing, provided they are assured that in publishing they are contributing towards the advancement of science and culture.

The first directors of the House of Macmillan established a tradition of *esprit de corps* among everyone connected with any book—author, publisher, editor, printer, and all staff concerned—a tradition which is kept very much alive to-day. Contact with authors was always of the closest, and contact and intercourse between different authors was often stimulated through the agency of the directors. This is well illustrated by the list of guests who attended a dinner at the Savoy Hotel on November 22, 1894, to celebrate the twenty-fifth anniversary of the establishment of NATURE.

Mr. F. Macmillan
Mr. G. Macmillan
Mr. M. Macmillan
Mr. G. L. Craik
Mr. J. Norman Lockyer
Sir George Stokes
Dr. D. MacAlister
Prof. Silvanus Thompson
Prof. H. E. Armstrong
Dr. J. H. Gladstone
Prof. T. G. Bonney
Mr. C. B. Clarke
Dr. D. Ferrier
Prof. R. Meldola
Prof. W. Ramsay
Mr. Hughes Lockyer
Mr. W. Crookes
Dr. E. Klein
Dr. M. Bruce
Dr. W. Hood
Sir J. Crichton Browne
Dr. E. B. Tylor
Dr. P. L. Sclater
Prof. A. G. Greenhill
Prof. H. H. Turner
Sir A. Geikie
Prof. Alfred Newton
Rt. Hon. T. H. Huxley
Sir H. E. Roscoe
Sir John Evans
Mr. F. Galton
Mr. A. E. Shipley
Prof. Marshall Ward
Mr. F. C. Penrose
Sir W. H. Flower
Dr. Michael Foster
Prof. T. E. Thorpe
Mr. J. N. Langley
Prof. G. B. Howes
Mr. W. H. Preece
Capt. Wharton
Prof. Roberts-Austen
Prof. Ray Lankester
Dr. Lauder Brunton
Mr. W. T. Thiselton Dyer
Prof. Burdon Sanderson
Prof. A. W. Rücker
Dr. Thorne Thorne
Mr. D. E. Jones
Prof. C. Allbutt

Present-day readers will note the high percentage of names which have now passed with honour into the annals of scientific research, education and scholarship.

It is not necessary to give an exhaustive list of names of men of science whose text-books, treatises and theses have reached the scientific world through the House of Macmillan ; but a few of those whose names appeared in the catalogues of the first forty-odd years of Macmillans make interesting reading. Grouped under their various subjects, the following are examples :

Mathematics and Astronomy. Wilson, Todhunter, B. Smith, Christie, C. L. Dodgson (Lewis Carroll), Airy, Challis, Penrose, Lockyer, Routh.

Physics. Clerk Maxwell, Balfour Stewart, Rayleigh, J. H. Gladstone, Stokes, Oliver Lodge, Tait, Sylvanus Thompson.

Chemistry. Roscoe, Würtz, Watts, Thorpe.

Statistics. F. Galton.

Geography. S. W. Baker.

Economics. Alfred Marshall, J. N. Keynes, J. E. Cairnes, H. Fawcett.

Logic. W. S. Jevons, J. Venn.

Geology. Sedgwick, Geikie, Sabine, J. W. Dawson, Boyd Dawkins.

Biology. A. Newton, D. Oliver, T. H. Huxley, A. Russel Wallace, J. D. Hooker, Ray Lankester, H. C. Bastian, Wyville Thomson, T. J. Parker, Williamson, Gilbert White, Pasteur, Lubbock, Bower.

Medicine and Surgery. G. M. Humphry, Acland, J. R. Reynolds, W. H. Flower, Maudsley, Fox, G. Rolleston.

Education. Matthew Arnold, Dean Farrar, Thring, Sonnenschein, Meiklejohn.

Science Primers. These were some of the first attempts to bring authoritative science text-books within the reach of the schools. They began in 1872 with Roscoe's "Chemistry", and this was followed by Michael Foster's "Physiology", Geikie's "Geology" and "Physical Geography", Hooker's "Botany", T. H. Huxley's "Introductory", Jevons' "Logic" and "Political Economy", Norman Lockyer's "Astronomy" and Balfour Stewart's "Physics".

George Wilson, author of the "Five Gateways of Knowledge" and of several technological books, also figured in the earlier catalogues.

Such men of science, with the essential help of the House of Macmillan, did much towards building the tradition upon which a large number of British educational publications of to-day rest. But progress since those days has been rapid yet sure, so that among the several thousand titles in the present-day Macmillan catalogue can be found many names of first importance in the educational and scientific world.

It is doubtful whether most readers of books realize to what extent those books depend on their publishers as well as their authors. This applies more to educational texts, with graphs, tables, maps, diagrams, and so forth, than to any other type of book; and the same may be said of periodicals.

Among the present directors of Macmillans are two grandsons of the original Daniel Macmillan—Mr. Daniel Macmillan and the Right Hon. Harold Macmillan. At present, Mr. Harold's position as His Majesty's Minister in North Africa is, as one can well imagine, demanding all his attention. Mr. Daniel Macmillan is therefore shouldering a tremendous responsibility ; but well and truly is he doing it and thus carrying on the tradition established by his forebears—a staunch friend of NATURE, a keen judge of a good book, and an ardent worker for the advancement of education. In fact, those of us who have the pleasure of knowing him see much of what was clearly manifest in his grandfather. Impetuous to a degree, impatient of trivial matters, and, therefore, what usually goes with such characteristics, indefatigable in his efforts to do a grand job of work. While the House of Macmillan is able to carry on under the direction of men like the present Mr. Daniel Macmillan, NATURE and Macmillan educational policy have nothing to fear. His is a glorious heritage, and we and the whole world of science must offer him our heartiest congratulations on this anniversary.

MASS OBSERVATION OF THE PEOPLE

The Pub and the People

A Worktown Study. Mass Observation. Pp. 350. (London : Victor Gollancz, Ltd., 1942.) 16*s.* net.

MASS Observation is an organization which has been evolved to make objective studies of the way of life of the peoples of Great Britain. The sponsor of the movement, Mr. Tom Harrisson, was formerly a professional anthropologist, who, whilst working on the island of Malekula in the New Hebrides Group, came to the conclusion that the people in the wilds of Great Britain were as much in need of scientific observation as the cannibals of Malekula. On his return to Great Britain he teamed up with a newspaper reporter, Mr. Charles Madge, who was thinking along similar lines. Thus Mass Observation was born. In August 1939 it consisted of a team of whole-time paid investigators and a nation-wide group of voluntary observers providing information about themselves and their neighbours. This by way of introduction to the organization that produced this book.

For the three years prior to the outbreak of war, this group concentrated on an unnamed industrial town in the north of England, which, short of naming it, Mass Observation takes great pains to suggest must be Bolton. Four major points were considered: the role of the public house in the life of the town, politics and the non-voter, the part played by religion and the annual holiday at Blackpool. This volume deals with only the first of these issues, publication of the other three volumes being suspended for the war period.

"The Pub and the People" is neither a scientific report nor a readable collection of essays. Rather is it a collection of verbose—very verbose—superfluities, interspersed with a number of statistics, which, important though they may be, do little but substantiate empirical deductions which one would inevitably make during a period of regular pub-going. If a scientific report had been intended, this volume would not have been greater than one sixth of its present size. If the writers had envisaged a book that would appeal to any intelligent reader, the contained information should have been more carefully collated and edited.

The following are some of the more interesting facts that emerge from this orgy of words. In "Worktown", the ratio of pubs to people has decreased considerably since the Act of 1839 empowered magistrates to refuse to grant the renewal or issue of beer licences. In the pre-1939 period the pub played a smaller part in the life of the town than it ever did. (It is unfortunate that a short appendix could not have been included indicating the effects of the War on the nation's drinking habits.) As a cultural institution, the pub is a declining force. "Pools, radio, press, motor-culture, dance-halls too (to a surprising extent), cinema, do not create a social group of people sharing consciously the same experience. . . . They are slowly changing the whole aspect of England and no one seems to be noticing it." The latter part of this statement is typical of some of the sensational embellishments which clutter up this book ; this is bound up with complete disregard for objective truth. A frontal attack is made upon "the irresponsibility and ignorance of scientists", without indications of their deficiencies. Other interesting conclusions suggest that the regular pub-goer "puts away" fifteen to twenty pints of beer a week; the more people in the pub, the more quickly do individuals drink their beer; drunkenness is not necessarily dependent upon the drinking facilities available; the usual assumption that the time a pub is open directly affects drunkenness is shown to be unrelated to demonstrable fact. Above all, the main text, which occurs as often as one would expect in a bad sermon, is that the true function of the pub is that of a safety valve, a means of allowing partial release from tensions accumulated in the stress of living. With which, no doubt, we all agree.

T. H. HAWKINS.

MARVELS OF THE VERTEBRATE EYE

The Vertebrate Eye and its Adaptive Radiation

By Gordon Lynn Walls. (Bulletin No. 19.) Pp. xiv+785. (Bloomfield Hills, Mich.: Cranbrook Institute of Science, 1942.) 6.50 dollars.

LIMITATION of vision to a narrow range of wave-lengths of radiation is manifestly related to the absorption of radiant energy by protein and water. The importance of light as a directive agent is associated with a wide range of light detectors in invertebrates. As the pineal eye is relatively unimportant in vertebrates, these devices are crystallized in the two lateral eyes. These lateral eyes show a wonderful variety in structure and versatility in action. The whole subject of the vertebrate eye is discussed by Dr. Walls in his excellent book, which is a mine of information about the eyes of all sorts of vertebrates.

One of the outstanding problems is the difference between vision in air and vision in water. In the former, the difference in refractive index between cornea and air enables the cornea to exert a great effect on focusing the rays of light. In the latter, practically the whole of the focusing of light must be done by the lens. Therefore there is a general difference in the lenses of aquatic and aerial animals, those of the former being spherical and those of the latter flattened from before backwards. The case of Anableps is most interesting. These animals have two pupils. When swimming on the surface with their eyes half submerged they can see objects both above and below the surface. Through the upper pupil by the cornea and less curved sides of a pyriform lens objects above the surface can be focused on one part of the retina, while through the lower pupil and more curved ends of the pyriform lens objects below the surface are focused on another part of the retina.

When the animal is amphibious there are three possibilities. Its eye can be adapted for vision in water, its eye can be adapted for vision in air, or it may have a wide range of accommodation so that it can see fairly well in both water and air. The accommodation can be brought about in several different ways. The lens may be moved backwards and forwards, the curvature of the cornea can be altered, the lens can be compressed round its equatorial plane, the anterior surface of the lens may be made more curved by constriction of the lens by the iris, and finally the lens may become more curved due to the elasticity of its capsule on slackening the suspensory ligament by the ciliary muscles.

Adaptation to different intensities of light may be brought about by a wide diversity of processes. Diurnal, nocturnal and twilight vision are comparatively simple to accomplish. Vision in bright light is associated with the presence of cones in the retina. For dim light, rods sometimes supplemented by visual purple are used. When an animal is active in both bright and dim lights, a duplex retina with both rods and cones is present. Other devices are used to help in the process of adaptation. In some cases extreme variations in pupillary aperture are used. In other cases movements of the retinal pigment combined with movements of rods and cones occur, so that cones are exposed and rods shielded in bright light while rods are exposed in dim light. The linkage of the sensory receptor cells to ganglion cells is such that cones are best for good acuity. The action of the fovea in improving acuity is explained. Maculæ, sometimes two for each eye, are present in some species. The tapetum is recognized as a means of reinforcing the effect of weak light, thus making vision better for nocturnal animals. The pecten is said to be a means for bringing increased nutrition to the inner layers of the retina in species in which the blood supply to the ganglion cell layer is inadequate. The uniformity in number of cell layers in the retina is noteworthy. Sensory receptor cells, bipolar cells and ganglion cells are found in all retinæ. Is this uniformity due to some common physiological need, or does it indicate the stage of development of the cerebral cortex when the optic vesicles were first formed? The author considers that the original sensory receptor cells were cones, and that the rods were derived from cones. Cones are present in some diurnal animals although their phylogenetic predecessors have rods only. Dr. Walls suggests that these cones have developed from rods. Is it not possible that the power to develop either rods or cones is present in the early stage of the sense cells of any vertebrate? Visual purple has developed apparently independently in isolated species. Is it possible that there is some common feature present in many retinæ, although visual purple is produced in appreciable quantity in only some of them?

All these points and many others are adequately discussed in this volume: it is one which has been needed for some time. Where so much is excellent it may seem unnecessary to criticize details. The author considers that small multiple apertures in the closed irides of geckoes may enable them to obtain a greater depth of focus. The multiple images so produced would not be superimposed except by the action of the cornea and lens. If the openings were arranged in a circle or if the pupil were reduced to an annular opening as in Plecostonus, then spherical aberration would be reduced to a minimum. On p. 75 the author states: "No one photosensitive substance could be entirely responsible for colour vision". This statement is misleading, because colour photography is possible with a single photochemical substance. The discussion on the function of coloured oil globules in eliminating scattered light is good, but surely the presence of colour filters in front of certain cones must cause a differential stimulation, and it is difficult to imagine that this differentiation would have no effect on the animal's colour discrimination. In the domestic hen the coloured globules are such as would give rise to a colour vision similar to that of man. Is it possible that trichromatism is a necessary result of some biological factor, or is it due to some physical property of light?

The author calls his book a text-book. It should certainly be read by all biologists, including medical men, interested in visual problems. H. E. ROAF.

THE EXTREME PROPERTIES OF MATTER*

By SIR CHARLES DARWIN, K.B.E., F.R.S.

WE know a great deal about many of the fundamental properties of matter, and our knowledge enables us to assign limitations on its qualities; so that whereas improvements in materials are possible, we can assign limits beyond which it is fairly certain that these improvements cannot go. It is proposed here to examine some of the principal limitations of this kind. It is only possible to deal with a few of the chief ones, and the list will include the mechanical properties of solids, liquids and gases and some of their electric and magnetic properties.

Strength of Materials

We know a good deal by now about the forces which act between atoms. There are several rather different types of force which occur in various types of solids, and the type which concerns us here is the metallic one, since in considering the strength of materials we obviously turn first to the metals. The basic structure of a metal is a crystal, usually of one of the simplest and most symmetrical classes. In this crystal the atoms have each one or more electrons set free, and these wander about freely as a sort of cloud. This cloud of negative electricity acts as a sort of cement holding together the positively charged atoms. In addition, these atoms exert forces on one another, partly of the repulsive electric type that would be expected, but also others of a kind the principle of which is to be mastered only by going rather deeply into quantum theory. The behaviour of these forces can be imitated by thinking of atoms as exerting attractions or repulsions on one another, but these forces need no longer conform rigorously to the pure electric type. The only character of them that I need at the moment is that they are not to vary violently with the distance; that is to say, if in equilibrium one of the forces between two adjacent atoms is so and so, then if they are displaced to a distance not greater, say, than 20 per cent, this force will not have altered by more than, say, a factor of 2.

Let us now examine what we should expect for the strength of a crystal based on this model. Consider, as the most characteristic thing in a solid, its shearing strength. Fig. 1 shows two rows of atoms, each of which is intended to represent a whole sheet of atoms standing out at right angles to the paper. The sheets are held together by their mutual atomic forces together with those coming from the atoms in the sheets above *A* and below *B* which are not shown. In the unstressed condition the atoms of *A* and *B* are supposed to be exactly opposite one another, but this is unessential to the argument; the first atom of *A* would therefore be at the point *L*. Now impose a small shear by displacing the whole sheet *A* and all above it a little to the right. A force will at once come into play resisting this displacement, and we can tell what this force is by our knowledge of the shear modulus.

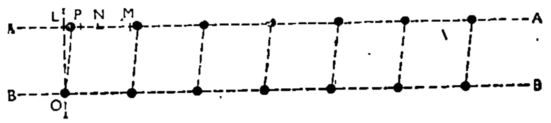

Fig. 1.

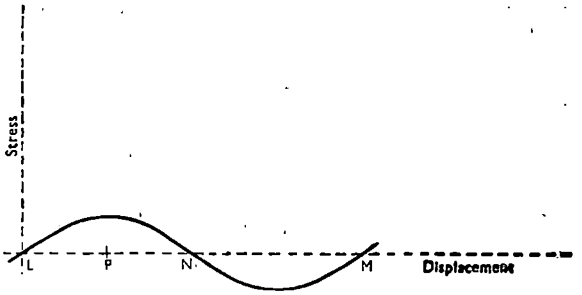

Fig. 2.

We can conveniently represent what happens by making a diagram (Fig. 2) in which the stress is plotted against the displacement of the sheet of atoms *A*, and the shear modulus gives the direction of the tangent at *L*. As to what happens farther on we cannot be sure, but we do know that if the *A* sheet is bodily transplanted one atom's length along to *M*, the force will vanish again, and around this point the curve will repeat itself. Moreover, half-way between there must be another point of equilibrium, and this must be unstable, because it lies between two points of stable equilibrium. This will be represented by the point *N* and a tangent sloping the other way. We do not know how to complete this curve, but we can make very useful conjectures about it. From all reasonable assumptions about the atomic forces being continuously variable with the distance between the atoms, we may say that the curve should have a reasonably smooth form. The simplest one to take is a sine curve, so we will adopt that. We know the slope at *L*, and the position of *N*, and from these it is elementary to calculate the height to which the curve rises at the point *P* one quarter way along from *O* to *M*. This will give the maximum stress that the metal can stand without yielding. An elementary calculation shows that this stress is $G/2\pi$, where G denotes the shear modulus. For a good steel the value of G is about 6,000 tons per square inch, and this suggests a shear strength of about 1,000 tons per square inch, in contrast to 10 tons per square inch, which is roughly the actual value.

The argument I have given suggests that a crystal of a metal ought to be very much stronger than it is; roughly it ought to be possible, without breaking, to shear a cube until it formed a parallelogram with angles given by the slope of *OP* in Fig. 1, that is to say, more than 10° off the right angle. This is completely contrary to the facts, for when a single large crystal is made of a pure metal it is found to be as soft as putty. This difficulty has been much considered, and I may refer to work of G. I. Taylor, who attributed the hardness that working gives the metal to 'centres of dislocation', that is, to imperfections in the ordering of the crystal, an effect which is practically universal in crystals. It would be out of place to go into his theory, but it confirms the point that to get a strong piece of metal one must have small crystals in it, not large ones.

If one examined the experimental facts without recourse to theory, one would conclude that it is the irregular junctions between crystals that make its strength, and that the metal is a sort of foam of these irregularities containing in its bubbles the putty-like crystals. But this is not a possible view, since we have to face the difficulty that those bubbles ought to be much stronger, by our previous argument, than the foam material between them. Moreover, there is an even greater difficulty in accepting such a view, because we know, at least roughly, the magnitudes of the atomic forces, and from them we can calculate what the shear modulus should be, and the answer comes out about right. Thus the crystals ought to be much stronger than the intercrystalline irregularities; and yet the more of these irregularities there are the stronger the metal becomes. We seem to be in the paradoxical position that a chain is strengthened by multiplying the number of its weakest links.

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* From the James Forrest Lecture of the Institution of Civil Engineers, delivered on January 12.

Some recent ideas of Bragg and others have done much to clear up the situation. In the model I took of the sheared crystal, I imagined the atoms on each sheet rigidly held together in relatively fixed positions. In fact, however, they are not fixed, since temperature dictates that atoms can never be at rest. Each atom is oscillating all the time in an irregular manner about its average position, and this makes possible a re-adjustment among the atoms without calling into play the strong stresses which would arise if the whole sheet had to be displaced like a rigid body. Consider the matter in more detail. A piece of metal is now to be regarded as composed of a large number of small crystals, all differently oriented and held together by a cement of irregularly placed atoms. When one of the blocks of crystal several layers thick is sheared a little, the displacements of the atoms (more strictly, now, of the average positions of the atoms) will call into play reactive forces which provide the shearing stress. But if the shear is made larger a new possibility occurs, which is that a slip should occur between the two rows. On account of the heat motions of the atoms this may now occur without calling into play the violent reactions that our previous argument suggested; and to decide whether it will occur or not we adopt the obvious criterion of energy, that is to say, if the strain energy of the slipped crystal is less than that of the unslipped, then slipping will occur. This is illustrated in Fig. 3, where the form *B* will have much less energy than *A*.

The result of this argument is to explain why large metal crystals are so much softer than small, for a shear of one half the atomic distance, measured across the whole width of the crystal, suffices to produce slip, and for a thick crystal this is only a very small shearing strain. There is much else in Bragg's work beyond this which I shall not mention, but we can see how it satisfies the two important conditions, first that it is the crystals themselves that dictate the value of the elastic modulus, and secondly that it is the reduction in size of the crystals that explains the strength of the metal.

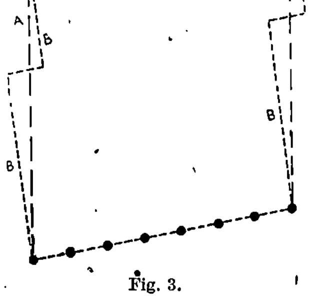

Fig. 3.

The question then arises whether we can use this theory to reduce the extreme limitation we have derived for the strength of the metal. Evidently the smaller the crystals the stronger the metal should be, but to what limit may we go? For example, if we could think of crystals only two layers thick we should be back at the earlier argument, but such a supposition would signify that nearly all the metal was composed of the irregular arrangements between crystals. An irregular arrangement of atoms of this kind is very like a liquid or a glass, and is very intractable to mathematical treatment, so that it is difficult to say what would happen from the atomic point of view. We may, however, be fairly sure that there would be some tendency to recrystallization, a sort of self-annealing, which would give rise to crystals up to a certain size, because we know that the process of annealing does tend to build up large crystals, and this tells us that the crystalline form has less energy than the glass form.

In this general connexion I would direct attention to the remarkable observations made some years ago by A. A. Griffiths, who found that a thin fibre of glass when newly made had a greatly enhanced strength. The value obtained was quite near that which would be indicated from the shear modulus as in Fig. 2, and this is most interesting as a confirmation of my general argument. With the lapse of time the fibre lost its excessive strength, presumably on account of recrystallization. Until we can know how far a similar recrystallization can be permanently prevented in a metal we cannot further reduce the extreme value we have arrived at for its strength.

As a general conclusion for the extreme limit of strength we may ever hope to attain, I therefore conclude that it is certain we cannot get beyond $1/2\pi$ of the shear modulus, and that it is most unlikely we can get beyond, say, one tenth of this—which would correspond to having crystals about ten atoms thick and to the rather unwarranted assumption that the irregular junctions would not provide a closer limitation. Since I cannot suggest any exact values for these further effects, I am going to play for safety, and take as the ultimate strength the value $G/2\pi$. This is about one hundred times as strong as existing materials.

Elasticity and Strength

Tension can be much more easily measured and tested than pure shear, and it is often more important in structures, so the engineer tends to think much more about it. I want, however, to raise the question whether tension is not really a secondary thing in the theory of the strength of materials.

The elasticity of an isotropic material has two properties which can be defined in a variety of ways: for example, by giving Young's modulus and the shear modulus, by giving one of them and Poisson's ratio, or by giving one of these three and the bulk modulus, that is, the reaction to hydrostatic stress. From any two of these the rest can be derived, and the only question is which are the best two to take? In other words, which are naturally the most primitive? A rather strong case can be made for taking the bulk modulus and the shear modulus as the two most primitive, since they correspond to the simplest types of strain which can be imposed on a solid body. In effect, this choice is made because it is easier to think of the stress as being called into play by an assigned strain, than to do what is done in a testing-machine, which is to apply a given stress and see what the strain is. If, then, we are to start with strain as given, there can be no question that a linear tension is a rather complicated thing, involving as it does both a distortion and a change of volume.

This point of view derives from the classical theory of elasticity, and it is a very tentative matter to apply it to the question of ultimate strength. In the first place, some materials break in tension and others in shear, as is easily seen from the shape of the fractured surface. The strongest materials always break in shear, and it seems likely that this is the fundamental manner. I should conjecture that breaking in tension is really a secondary business. If a bar under test contains non-uniformities there will result stress concentrations, and it is the shearing at these concentrations that causes the break. This is only a conjecture, but it leads to the plausible consequence that there is one cause, and not two causes, governing the strength of materials.

Now I have pointed out that the classical theory of elasticity suggests that the bulk modulus is a more primitive thing than is Young's modulus, and this suggests that we should consider what is the 'bulk strength' of materials, that is to say, the manner in which they yield under hydrostatic pressure or tensions. We can immediately answer half this question, for there is no doubt that the metal when hydrostatically compressed resists that compression strongly and shows no tendency to break under it. As to its behaviour under a hydrostatic tension we can scarcely give an answer at all, since it is impossible to apply such a system of forces to a solid. I know of only one experiment where something of the kind has been done. Joffe took a sphere of rock-salt crystal (which is cubic and not far from isotropic) and immersed it in liquid air until it was all of one temperature. He then plunged it in hot oil so that the outer parts expanded, and these parts applied a hydrostatic tension to the inside, which was still cold. The tension showed no tendency to produce cracks.

This one experiment is obviously a rather complex business, but it confirms a tentative conclusion that I wish to draw. The characters of solid matter may be divided into two types, namely, those sensitive to details of structure and those insensitive. All the elastic moduli are fairly insensitive, in that, for example, Young's modulus and the shear modulus are roughly the same for hard and for mild steels; but we know that the shear strength is sensitive. I want to suggest that what evidence there is points to the bulk strength being insensitive to structure. If this is correct, then we have the simplification of theory that we can impute the structure-sensitivity of tensile strength to the shear strength. The advantage of this point of view is that we have only *one* quantity to consider which needs close examination, while the second elastic character plays little part in the consideration of strength.

Liquids

The two main characters of a liquid are its compressibility and its viscosity. As to compressibility, there is little to be said. At one end we pass over into degrees of resistance to compression comparable with, but not so strong as, those of solids. At the other end we come up against the *critical phenomena* where liquid passes continuously into vapour, so that again there is no extreme property. Viscosity is more interesting. At one end we have highly viscous materials, such as treacle, then pitch, and then glasses which shade into plastic materials and become indistinguishable from solids. I may also refer to those highly peculiar substances which appear quite stiff but gradually become liquid on stirring, and the converse ones which are liquid, but become stiffer and stiffer as they are stirred; but the theory of these is rather obscure and I must not attempt to discuss them.

At the other end, that of small viscosity, there is much more interest in a particular substance which was discovered only a few years ago. This is liquid helium II. Helium is the substance with the lowest boiling-point of any, about 4° absolute. Liquefaction was achieved in 1908. The next thing to do was to solidify it, but for long no success was achieved, until finally in 1925 it was found that high pressure was essential, and that solid helium could exist only at a pressure of more than 20 atmospheres. But a much more remarkable thing was also found. At ordinary pressures the liquid suddenly changes its character at about 2°. Above this temperature liquid helium I is a fairly ordinary fluid, with a density of about 0·1, and with viscosity and specific heat about the same as those of other liquids. At 2° there is still no change in density or specific heat, but the viscosity drops to a very small value indeed and the heat-conductivity becomes enormous—a hundred times better than that of copper. That, at least, was how the matter appeared at first; but there was a good deal of discrepancy between the measures of various workers, and it was suspected that the viscosity was so low because in every measure turbulence had occurred, while measures of viscosity depend on using such fine tubes that turbulence is eliminated.

Later work has suggested that the matter is not so straightforward, and, in fact, that the character of the substance is not to be explained in terms of the ordinary language used for liquids; but the business is by no means clear yet. We may say, however, that a solid body could move extremely freely in helium II, and that it is practically impossible to keep bodies at different temperatures in its presence: and it has another remarkable characteristic in that the liquid can creep over any surface in apparent defiance of the laws of hydrostatics, so that if a tea-cup were filled with it, in a short time the liquid would appear in the saucer, and then on the table, and finally the level of the liquid would be the same all over whatever space was available.

Gases

When we come to gases there is little to be said, as the gas laws are very precise and admit of little variation. There are variations of equation of state near the condensation-point, but in the truly gaseous condition the only variety is in the density and the specific heat. The most interesting quantity is the ratio of the specific heats, which governs the law of adiabatic expansion and the speed of sound; this is 5 : 3 for monatomic gases, 7 : 5 for diatomic, and still lower for more complicated molecules. We can say at once that 5 : 3 is the highest ratio that could ever be possible. With regard to density, we can say quite definitely that the limit of lightness is attained by hydrogen.

But if I may extend the meaning of the word 'gas' there are much more interesting things to be said. There does exist matter which is much lighter than hydrogen. This is the electron, which has a mass

1/1840 of that of a hydrogen atom. Electron gas can have only a transient existence, because the enormous repulsive electric forces blow it to pieces at once; but we can take advantage of this transient existence in a more limited way. This is especially in connexion with *relays*, which turn a weak cause into a strong effect. In a quick-acting relay, inertia is obviously of the chief importance in making a given force produce the quickest effect. The force on a body, which in the most delicate systems is almost always electric, depends on the electric charge, while the motion depends on the mass, so that e/m is a measure of the capability of a system to act as a relay. The e/m of the electron is 1840 times as large as that of the next best system, the hydrogen atom, and proportionately again better than that of heavier substances. It is this enormous factor that is responsible for the high qualities for amplification of the thermionic valve amplifier.

We know of no reason or evidence that there is anything in the nature of a 'sub-electron', so that we have arrived now at the ultimate limitation in relaying action by the use of the properties of a transiently existing electron gas. It is true that there is something less heavy than electrons, and this is light itself, which carries energy but has no *rest-mass* at all. I have to word this carefully, because in a wider sense anything with energy has mass. But something besides light must always occur in a relay, because at some stage the light has to be acted on or to act on matter with ordinary inertia. The efficiency of a relay is that of its heaviest part, and so we cannot hope by any means to improve on the electronic valve.

Although a free electronic gas can only exist transiently in a tube, there is an extended sense in which it is of much commoner occurrence; this is in the interior of a metal. Here there is a framework of positively charged atoms to neutralize the electron charges, so that the gas can now be permanent. Such a gas has certain properties which are entirely different from those of an ordinary one, a fact which was first recognized with the discovery of the new quantum theory fifteen years ago. The molecules of an ordinary gas are moving about with various and frequently changing velocities, and the frequency of occurrence of these velocities is governed by Maxwell's law of distribution, giving the average numbers at any instant with each velocity in the form of the well-known 'cocked-hat' error law, the size of the curve depending on the absolute temperature.

The electron gas has its velocities distributed quite differently. This is because of the exclusion principle, one of the basic principles of the quantum theory. I must not go into technicalities, but the rule is that two electrons must never be doing the same thing. Thus, if one electron is at rest in the metal no other can be at rest: in an ordinary gas there is no reason why many molecules should not be at rest simultaneously. There are a great many electrons in the metal, and they comply with all the conditions of low energy and many of the higher, so that a lot of them are forced to have quite a high energy. Instead of the Maxwellian figure we get, at ordinary temperatures, a curve with a very sharp fall to zero. The speed at this break corresponds to what in the other curve would be given at a temperature of about 10,000°. To misstate it in picturesque language, the exclusion principle squeezes the electrons out of their rightful temperature; if the metal could be raised to 10,000° without melting, then for the first time the electron gas would behave something like an ordinary gas. I wish I could enlarge further on this, but it is hard to do so without going more deeply into technicalities. Moreover, my main purpose in mentioning it at all has been because I shall want to return to it in the next subject for discussion.

Density

We have already considered what is the lightest substance. It is natural next to ask what is the heaviest. Forty years ago there would have been the immediate answer, metallic osmium which has specific gravity 22, and the only saving clause would have been that there might be other unknown elements which would prove heavier. We now know that there are no unknown elements and yet we must answer the question quite differently. This is on account of certain very unexpected astronomical discoveries of about fifteen years ago. Certain stars were discovered which gave out light at a white heat and yet were very faint; they were therefore called white dwarfs. The white heat implied a high temperature, and with this temperature they had no business to be faint; their faintness could only be explained by small size, and this implied a very high density. For example, the companion of Sirius is about the weight of the sun but about the diameter of Uranus, and therefore its mean density must be about 50,000. At this density a cubic inch of the material would weigh about a ton.

The general theory of these dwarfs is understood, though no one knows yet fully why they occur, and what happens to them ultimately. Their structure is an extreme case of the electron gas in a metal. In the interior of a star the temperature is so enormous—millions of degrees—that the atoms lose most of their electrons, and this large number of electrons becomes subject to the exclusion principle. According to this principle there is a simple relation between pressure and density which is independent of temperature; it is the same relation as that which applies for the adiabatic expansion of a monatomic gas. So long as the temperature is not too high (and by high temperature I now mean something like a hundred million degrees) this relation holds and implies that under sufficiently high pressures there is no limit to the density. As in most things of this kind, the result must not be pushed too far, because we have omitted certain secondary matters which ultimately become important. But there is good reason to believe that in the deep interior of white dwarfs there are densities of something like two tons to the cubic inch—specific gravity a hundred thousand—which are maintained by pressures of the order of a million million atmospheres. It seems reasonable to hope that this is a final limitation on the density of matter.

Electrical Properties of Matter

What is the best insulator we can hope for? Here the answer is fairly definite; we already have it in the form of good transparent crystals such as quartz. The theory of insulators, as formulated nowadays, is curiously like that of conductors. The individual electrons in both are free to move about in the crystal, but the exclusion principle leads to an important difference. In the case of metals there is, so to speak, room for an electron to behave in a different way from what it is doing—not all the seats are occupied—so that it can wander about carrying its electricity with it. In an insulator there is a full house, so that when one electron shifts its place another is forced at once to take that place, and there can be no transport of electricity, and so no conduction.

There are two ways in which insulators fail. First, the surface often becomes covered with some foreign material, often merely water, which causes a leak over it. The second failure is much more interesting. One way of escaping from the rigour of the exclusion principle is to provide an electron with a good deal of energy, because then it can be 'doing something different' from the others. If a crystal, say of rock salt, is illuminated with ultra-violet light, some of its electrons absorb the light and acquire a high energy which sets them free to wander through the crystal. In this way a conductivity not unlike that of electrolysis arises. To get a perfect insulator this must be avoided, and it can best be done by keeping the crystal in the dark and, since there is always radiation due to temperature, to make it very cold will also help.

At the other end of the scale, what is the best electrical conductor ? Here also we can make a rather definite answer. The conductivity of alloys is worse than that of their constituent elements, both theoretically and in practical experience, so that we need only examine the table of the elements to see which is best. If we reckon by weight this is sodium, but others are nearly as good. But a far more important question is the temperature. The conductivity improves with cold, and tends to very high values at the absolute zero. It is not certain whether it might not become infinite, but as a general rule there seems to be a small residual resistance.

The interest of this is very much diminished by the extraordinary phenomenon of superconductivity. Certain of the elements—not by any means the best conductors at room temperature—and also some alloys and compounds, as the temperature drops, suddenly become perfect conductors ; lead does so at 4° K., so that if a current is started in a lead ring below this temperature it just goes on for ever—always provided the stock of cooling liquid lasts. This is a fascinating subject of study, not by any means cleared up yet, which possesses many of the characters of the older physics of Faraday rather than of modern atomic physics. There are, however, pronounced limitations in its practical utility because superconductivity is sensitive to magnetic fields, and fails when the field is strong, so that if too great a current is carried by a superconducting wire, that current's own field destroys the superconductivity.

Magnetism

The question of magnetism is also interesting because such great technical advances have been made in it lately. I can only touch on some parts of the subject, in particular on permeability and saturation values. Of these, the permeability at low fields is important for many purposes. The value for mumetal is about 60,000, and we may ask whether this could be increased.

According to present ideas, iron and nickel have the property of being spontaneously magnetized in small domains, and all that the external field does at first is to turn the direction of spontaneous magnetization into another direction of easy magnetization. There does not seem any particular limitation on this process, so that we can see no reason why quite a small field should not give practical saturation. Thus we know no reason why there should not be a better mumetal in the sense that the permeability for weak fields might be much larger ; but correspondingly the exciting field would have to be reduced, or saturation would ensue.

The question of magnetic saturation may be answered much more definitely, since there exists a fairly complete atomic theory. We can say that it is certain that nothing can show magnetic saturation much greater than that of iron, and it is extremely unlikely that anything will be found perceptibly better than iron. In this matter of saturation we are not concerned with the ease or difficulty with which the magnetization can be set up. In iron it is spontaneous, whereas in some substances it calls for such strong external fields that nothing like the maximum has ever been attained. There is a natural unit of magnetization, the Bohr magneton, but theory indicates that there is no reason why an atom should possess an exact whole number of magnetons. Thus iron has 2·2, cobalt 1·7, and nickel 0·6. The largest number known is in the rare earth europium, some salts of which have 10. This is in exact accord with theory, and as the theory has been applied to the whole table of elements, we can confidently say that it is no use expecting anything better. This magnetization is in the salt, where the europium atoms are fairly far separated from one another, so that the total magnetization is not very large. The europium atom is three times as heavy as the iron atom, so that even if the full magnetization could be produced in the metal, the resulting value would only be half as much again as it is for iron. That is why I said that there was very little expectation of getting anything better than iron.

Summary

I have ranged over a wide field of properties of matter, and had better summarize them in conclusion. I am going to do so in a fanciful manner by taking a structure built out of all the extreme materials I have imagined and seeing what it is like.

I propose to rebuild the ship *Queen Elizabeth.* My metal is one hundred times as strong as that used in the present ship. I do not propose to go into complicated questions of design ; for example, the tension members can be immediately lightened one hundred times, but the thrust members will have to be much enlarged tubes in order to remain stable. I see no reason why I should not build the ship with one-hundredth of the weight of material. As the ironwork weighs something like 30,000 tons in the present ship, my ship will weigh only 300 tons. Therefore, to get the displacement, I shall have to ballast it with nearly 30,000 tons before I begin to put in the cargo. I immediately think of using material from a 'white dwarf' star for this, and my ballast will then occupy about 17 cubic feet. However, I now notice that there will be technical difficulties in this way of doing things, since I should have to keep it at a pressure of one billion atmospheres and at a temperature of one hundred million degrees, so I give up this idea and fall back on ballast made of metallic osmium, of which I shall require as much as 50,000 cubic feet, say a block in the form of a cube of 12 yards side. It is time now to attend to the machinery. Presumably I shall think of putting in an atomic engine, but the trouble is that whatever the engine itself may be like, so far as I can see it will have ultimately to raise steam for a turbine, so that my engine-room will still have to be quite large. For the auxiliary machinery I will certainly take advantage of superconductivity, so that the wiring of the ship will be cooled by liquid helium; it must be made of tin or lead wire, since copper is not a superconductor. The magnets in the dynamos will scarcely be different from those already in use.

This suggests a further flight of fancy. My ship on its journeys still has to contend with the resistance of the water. Would it not be more economical to alter the composition of the sea into something less resistant? If it is liquid helium II, I can economize in many ways. I shall need no special cooling for the superconducting electric wires. I can leave out nine tenths of the ballast, since the density of the sea is now reduced to one tenth. It is possible that I can give up having an engine altogether by giving the ship a good shove at the start of the journey and receiving it on buffers at the end; I know too little about the real viscosity to judge of this.

But the end of all my plans is tragedy. On account of another of its properties the liquid helium II will irresistibly creep up the sides of the ship, over the bulwarks, across the deck, and down the companion ways, until it settles in the hold, in the effort to come to the same level inside as out. Deeper and deeper will grow the water in the hold, and deeper and deeper the ship will settle, until at last my imaginary ship will founder in the depths of the imaginary ocean.

RESEARCH IN THE NETHERLANDS INDIES*

By Dr. P. HONIG

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RESEARCH in the Netherlands Indies which tried to improve existing or developing processes was, and is, principally concerned with agriculture in all its aspects. Research in the field of mining had to do with the geological surveys of mechanical engineering as well as metallurgical and civil engineering.

Most of the progress in the Indies has been culled from experience gained in Europe; new scientific aid from Japan, other countries and even from the United States has been of limited significance, except, perhaps, in military matters.

It is not the purpose of this article to discuss medical research, although in the past fifteen years the relation between nutrition, hygiene and the health of the population has been intensified.

Research, as it has been organized in the Netherlands Indies, has to do, primarily, with agriculture and technology. Agriculture includes agrogeology, diseases (phytopathology and entomology) and the methods of planting, selection of varieties, application of fertilizers; the study of technology is directed towards improving the methods of manufacture of agricultural products.

The beginning of research work in the Netherlands Indies is seen as far back as the origin of the Botanical Gardens in Buitenzorg some sixty years ago. Without doing injustice to its former directors Teismann and Blume, or to individual explorers such as Rumphius and Junghuhn, the real beginning of systematic research began about 1880. Before that time, however, there was a separate survey of the natural wealth of the Netherlands Indies, with the idea of having a detailed summary on minerals, fauna and flora, the geological formations, and the character of natural conditions regarding temperature and weather.

The principle of using science and scientific men to improve existing agricultural industries was first developed in Europe, and it is certain that Germany played a leading part during 1870–1890 in this matter. Treub, of the same era, was ideal as director of the Botanical Gardens. He worked on the plan of introducing science for practical application, although it was his original contention that most of the scientific research, for application to special plantation crops, must be affiliated with Buitenzorg. He believed this necessary in order to centralize in one way or another the scientific work; he thought it to be advantageous to move scientific workers about. The idea of centralization was not used, however, by the new "Proef-stations", as the first research centres were called.

The first research centres were organized as private institutions. There were stations for sugar, tobacco, coffee, indigo and for forestry in general. Later, there followed similar centres for tea, rubber, cinchona, palm oil. Then came the Government Agricultural Institute for the study of native crops: rice, copra, cassava, soja, maize and similar produce. The research organizations previous to 1900 employed, in general, phytopathologists; but later agriculturists and biologists, specializing in genetics and physiology, were introduced. In 1930, for example, the total number of workers on the staffs of the Netherlands Indies Governmental and private institutes was 190. These included those working in the fields of agriculture, agricultural industries and technology. All of them were graduates and experts.

At the start, the selection of the research workers was on a broad international base, and most of the European countries sent men of science to work in the Netherlands Indies. This international co-operation was of great benefit to the country. Further, there were the universities in Holland where it was possible to give a limited number of students thorough training. The Netherlands Indies also had the good fortune to have men of science who could read three major foreign languages.

The total number of experts who worked in the Netherlands Indies from 1880 until 1935 was about 850. About 250 of these men had been connected with the Experimental Station for the sugar industry. More than one quarter were foreign residents, while the average time these men were connected with research in the tropics was seven to eight years.

The total number of chemists, agriculturists and biologists engaged in the Netherlands Indies was much greater, however, than the above-mentioned figures. In 1939, there were 250 chemists, of whom 50 were doing research; the others dealt with education, manufacturing processes, consulting agencies and the like. Of the agriculturists, research workers numbered 45 out of 700 in 1939. There were 90 biologists with 25 research workers. The geologists numbered 70, of whom seven were engaged in research. The number of pharmacists was 200, eight of whom were research workers.

Until 1939, the number of Indonesians and Chinese working in science was very small, and the indigenous part of the population provided only five research workers. Their contribution to scientific literature was likewise very small.

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* Substance of an address given at the September meeting of the Society of Netherlands Scientists in the U.S.A. at Cornell University.

Following the publication of works on science in the tropics, much controversy arose on 'the creation of new wealth'. It was considered for some time, in effect, that the result of scientific study was the property exclusively of those who were paying the bills. Furthermore, they were secret. On the other hand, it was advocated that for scientific progress it was absolutely necessary that publications should be sent to colleagues working in the same fields in other countries, and that free co-operation be a requirement.

Discussion on these points of view began during 1930–32, years of the severest depression. Companies existing at that time thought that a number of foreign competitors had profited specially by the studies in the Netherlands Indies; that the methods developed in the Indies were only copied when free access had been given to all those who were interested in the results of the research work.

Unfortunately, this discussion had as defender a professor. The rights of the vested interests were defended by a lawyer, who evidently put forth the cause of the financing companies to limit and even to forbid foreign co-operation among the scientific workers. In 1933, the final decision for most of the experimental stations was to drop the open-door policy and to try to keep as secret as possible future results from the laboratories. The steps so taken were undoubtedly bad. Only the worst type of 'man of science'—the unreliable and selfish type—saw in this policy of secrecy an opportunity to exploit his own position and his own acumen. In the small, closed communities of manufacturing companies, generally speaking, objective criticism was lacking; and prominence was given those who talked a great deal but said little. The best scientific workers were more or less ignored.

During this unhappy period, the Council for Natural Sciences in the Netherlands Indies made an attempt at a certain amount of co-operation as a counter-measure and, if possible, for the entire Netherlands Kingdom. It did this by an organized exchange of experience between the stations and professors of natural science in Holland, who were acquainted with the problems of the tropics. To this date, however, the matter remains unsettled.

Most of the studies on the Netherlands Indies are published by the stations themselves, usually in the Dutch language, but, where there are large foreign interests, as in the rubber industry, in English as well. The number of technical periodicals distributed throughout the whole world before the War was: engineering, 1; medical, 3; geological, 1; pharmaceutical, 2; chemical and technological, 1; sugar, 2; general agriculture, 3; tea, 1; rubber, 2; cinchona, 1.

In 1914, periodicals in the Netherlands Indies totalled seventeen. About nine tenths of all the studies in the Netherlands Indies were published in these journals, while one tenth was found in other countries. Before the War, the material was contained in Dutch publications; at present it is found in American and British periodicals.

Studying research on the Netherlands Indies reveals excellent co-operation with other countries. The share of work done by foreign men of science, among whom may be mentioned Germans, Swedes, Swiss and Russians, is important. The relations between nationalities and scholars of different universities have been of benefit to all. In the past years, selection of scientific workers has become limited and the trend was preferably national. An additional limiting factor was that well-known professors, or high officials, in the Netherlands were used as liaison officers for the selection of young graduates to be sent to the Dutch Colonies.

There appears to have been an unfortunate narrowing of the field from which men are selected in the Netherlands Indies. After the War, it is to be hoped that all men of science interested in the Netherlands Indies, and living and working in other countries, will stimulate their students to go to the Indies for work and study, because working in the tropics can prove an excellent occupation. The number of research workers in the Netherlands Indies, which has been given above, is very small. The United States has at present 70,000 experts working on natural science. In the Netherlands Indies there is a maximum of 300, partly because some of the findings, especially in connexion with the oil and tin industries, are made in other countries where facilities are better than in the Indies.

The United States at the present time is spending 300 million dollars a year on research. In the Netherlands, three years ago, expenditure amounted to 3 million guilders, which meant that of the exports about one half per cent of export money was used for research. It is generally believed that money used for data on the Netherlands Indies yields profitable returns. In some cases, such funds have had to be increased; but, because of the conditions of prices and quantities of produce to be exported, it is very difficult to stabilize the amount.

It may be expected, however, that the money will be increased eventually. Previous to 1930, more than 80 per cent of the research work was done by private organizations. The trend now is that much more will be done by Government or by private institutes under Government control. It is also to be expected that after the War the Netherlands Indies will ask for more research workers and that they will be asked to come from widely divergent places. The Netherlands Indies are dependent on foreign sources, not only for the scientific workers themselves but also for equipment and literature. Only laboratory buildings and assistants are available in the Indies.

Many countries are even now considering how this research can be directed, including the Indies, where the Government had founded the Council for Natural Sciences for the Netherlands Indies. This may be compared with the Koninklijke Academie voor Wetenschappen, which studied and promoted scientific work in the Netherlands Indies. One of the difficulties for a practical organization is that a number of the directors of experimental stations there must be trained to the right responsibility. Their attitude must still be made more active regarding the proper locale for scientific work, and there still is misunderstanding on the part of a financial board. The director of an experimental station must be convinced that he is the one responsible for the work turned out. He must not be passive about defending the rights of the scientific workers and in finding a proper solution for publication policy as well as in stimulating co-operation. In most experimental stations the scientific locale and general set-up do not rise above the scientific and social outlook of their directors.

Considering the specialized science already established, it may be asked: What of the men themselves to be selected for the future ? A start was made with chemists, and later biologists and agriculturists arrived, followed by the biochemist.

So, the first step to take after the War is to seek men who are suitable. The specialized research worker is not so important, for too much value has been attached to the title rather than to the man, his experience and qualifications. A 'clan' formation in the scientific world may develop with biologists sticking together and agriculturists training themselves in mutual admiration. It must be realized that the physicist, as well as the engineer, the biochemist and the technologist are also useful.

In the Netherlands Indies there has always been considerable discussion about pure and applied research. Naturally, there is not a single experimental station which is not interested in fundamental research work, without regard to specific applications of the facts to be discovered. The danger of an experimental station is not that it is doing too much on pure science, but that a research institute has also to act as a consultant.

In certain conditions, this can result in lack of time for real research. The research worker should not be spoken of as an impractical, unsocial, professorial type, with the "zeal and satisfaction of the crusader", in devoting his whole life to science. Perhaps in the past there have been certain of this extraordinary type of man ; but those who have been in the Netherlands Indies were no strangers in the economic world, and their outlook upon life was just the same as that of common men with common sense. Most of them, however, had great zeal, with an honest idea of scientific truth and with intelligence above the standard.

The Council for Natural Sciences, which has been studying the scientific future for the past two years, will play a leading part in choosing intelligent and zealous men of science, because it is convinced that governmental encouragement and support of research is a necessity ; that the best form for this encouragement is to provide sufficient assistance to existing associations ; and that all research should not be handled by a centralized governmental service. Decentralization of research, with boards interested in the problems to be studied, is the future development to be desired. Further, the funds for research must be increased.

It should also be possible in the future to criticize frankly research in certain industries. The Netherlands cinchona industry, for example, which had been a profitable one, was only using pharmacists and keeping secret everything which they were doing. According to the general feeling of a great number of men of science, however, insufficient research on the details of bark composition, quinine chemistry and manufacture of substitutes was being done ; the industry felt that it was in a safe corner with its secrecy and profits ; but a world with more freedom is the goal, and such secrecy is unpalatable.

An important factor for the future of the Netherlands Indies is that it has decided to create a complete university, with courses in all the natural sciences, to be maintained on the same level as the Dutch universities. Such a university would be an important centre of research in the future. The problems of society *vis-à-vis* science in the Netherlands Indies are not confined to this country. They are general world problems. We must do away with the secrecy impressed upon men of science by their employers. Open discussion is the best for the enlightenment of business executives, and it must be made possible for every man to discuss his work and aims. The post-war scientific world in the Indies must have workers in a free world who feel they belong to a group which has forgotten all limitations set by frontiers, races and laws—because science is one of the expressions of the higher unity of mankind and the world.

ORIGIN OF MALIGNANT TUMOUR CELLS

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IN the light of recent knowledge of chromosome chemistry and gene action and its bearing on the interpretation of the mitotic cycle in the cell, a cytological analysis was carried out on 565 human tumours (carcinoma of the skin, œsophagus, colon, rectum, larynx, lung, cervix, uterus and breast)[1]. It was expected that by analysing the characteristics of chromosome and nucleolus behaviour, abnormalities specific to the internal organization of tumour cells might be detected. The present article contains a brief summary of the data obtained[2].

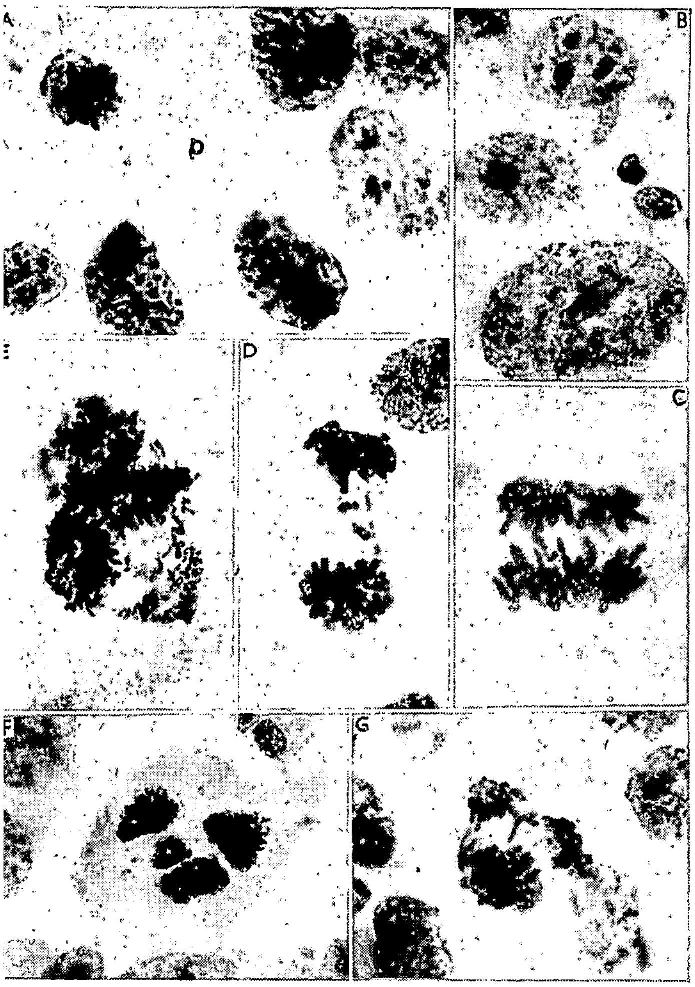
Nucleolus

Pianase[3] had already reported that the nucleolus, a permanent structure in the resting nucleus of cells, is larger in tumours than in normally functioning tissue. His observations have been corroborated since by many investigators[4]. During the last few years cytogenetical research has accumulated experimental proofs that the nucleolus is produced by the so-called 'nucleolar organizers', which are a group of genes located in particular regions of the chromosomes[5]. Nucleoli are formed at the completion of mitosis and their size may increase during the resting stage. They disappear at the beginning of the prophase of the succeeding division. Although there are great differences in the histological structure of tumours of different tissues, the behaviour of the nucleolus is always the same.

It was observed that (*a*) nucleoli in cells of the same tumour differ in their chemical contents ; (*b*) they are of varying size ; and (*c*) nucleoli in cells of different tumours of the same kind may differ in both, that is, in size and chemical content.

Nucleoli giving Feulgen's positive reaction are known to contain desoxyribose nucleic acid ; they usually appear as small, deeply stained granules (*A* in accompanying photograph). Such nucleoli represent heterochromatic regions in the chromosome, which retain the nucleic acid charge during the resting stage. In nucleoli which give a Feulgen's negative reaction, on the other hand, desoxyribose nucleic acid is absent, and, as ultra-violet absorption indicates, there is a large amount of protein of the histone type and the ribose form of nucleic acid. These nucleoli are large (*B*), and they show great variation in size, which is due to the different amount of histone-protein and ribose nucleic acid present.

It is seen that tumours are not homogeneous from a cytological point of view, but are composed of cells with Feulgen's positive and negative nucleoli.



., Tumour cells from cervix, showing the small Feulgen's positive nucleoli (× 800). B, Tumour cells from cervix with large Feulgen's negative nucleoli. One cell is olyploid (× 800). *C*, Anaphase in squamous cell carcinoma of the skin showing ne non-disjunction of a chromosome (× 800). *D*, Telophase in basal-cell carcinoma howing chromosome bridge and lagging of chromosomes (× 800). *E*, Highly polyloid cell in carcinoma of the cervix (× *c*. 670). *F*, Multinucleate giant cell in rcinoma of the cervix (× *c*. 670). *G*, Tri-polar spindle in carcinoma of the cervix (× 800).

The analysis has shown that the proportion of these cells varies (*a*) in different regions of the same tumour at the same time, (*b*) in the same tumour at different times, and (*c*) in tumours of different kinds. The proportion of cells with Feulgen's negative nucleoli increases at the expense of the other cells with the development and growth of the tumour.

Mitosis

Tumour cells exhibit a great variation in respect of the details of division. Tumours were found in which most of the dividing cells undergo the process of mitosis normally; on the other hand, tumours were encountered in which a great proportion of dividing cells have shown many abnormalities. These are expressed in chromosome structure and behaviour and in the lack of co-ordination between spindle mechanism and chromosome movements. A close relationship was found to exist between the frequency of abnormalities and the type of nucleolus. While tumours in which the proportion of cells with Feulgen's negative nucleoli is very small exhibit few abnormalities during mitosis, tumours in which the proportion of these cells is high contain a great number of polyploid and giant cells, and most of the dividing cells exhibit various chromosome and spindle abnormalities. Some of the most common abnormalities observed in tumour cells are summarized as follows:

(1) *Stickiness of chromosomes.* At anaphase and telophase of mitosis in tumour cells the daughter chromosomes remain associated. 'False chromosome bridges' are formed, which prevent the separation of the telophase chromosome groups and may lead, by the failure of division of the cytoplasm, to the formation of binucleate cells. This stickiness of the daughter chromosomes caused the configuration, described by Farmer, Moore and Walker[6] as a "bivalent" because it is very similar to that found during the first meiotic division. On account of this similarity they erroneously believed that carcinogenesis is a process similar to gametogenesis abnormally occurring in somatic tissues.

(2) *Non-disjunction of chromosomes.* Daughter chromosomes often fail to segregate to the opposite poles (*C*, *D*), consequently the two nuclei formed will be unbalanced in respect of the chromosomes content. This abnormality is due either (*a*) to chromosome stickiness or (*b*) to rapid division.

(3) *Displacement of chromosomes.* One or more chromosomes may lie off the equatorial plate during metaphase. Such chromosomes are usually unoriented in relation to the centrosome and spindle.

(4) *Clumping.* The chromosomes during metaphase fail to form a well-defined equatorial plate. Clumping often interferes with chromosome segregation and may result in the degeneration of the chromosome elements.

(5) *Binucleate cells.* These are the result of the failure of cell division to take place after nuclear division.

(6) *Polyploid cells.* In these cells the 48, that is, the diploid chromosome number, is multiplied; the cells are larger than diploid cells. They are due to the failure of spindle formation.

(7) *Multinucleate cells.* These are the result of 'polymitosis' or repeated nuclear division, without cell division (*F*).

(8) *Giant cells* with highly polyploid chromosome number (*E*); these are due to rapid division. Such cells very often degenerate.

(9) *Spindle abnormalities*: (*a*) delay in spindle formation, (*b*) incomplete and (*c*) multipolar spindle (*G*). The result of such spindle abnormalities is incomplete or irregular chromosome segregation, and the formation of unbalanced or polyploid nuclei.

Discussion

The analysis of this aberrant chromosome and spindle behaviour has shown that they are chiefly due (1) to stickiness; and (2) to increased rate of division. It was concluded as a result of the analysis that not only the characteristic abnormalities such as polyploid, multinucleate, and giant cells, multipolar spindles, stickiness, displacement of chromosomes at metaphase in tumour cells, but also the increased rate of division itself can all be attributed to a quantitative change in the nucleic acid synthesis. The argument is here presented, and it is based on data obtained by Astbury[7], Caspersson[8], and Darlington[9].

The chromosomes are known to be long polypeptide chains on which are fixed, at regular intervals, active groups, identified genetically as the genes. The genes, besides being the physical basis of heredity, regulate the division of the nucleus, by attaching to themselves the nucleotides of desoxyribose nucleic acid, which polymerizes in columns (thymonucleic acid) parallel with the polypeptide chains. The polymerization of thymonucleic acid is responsible for (1) the coiling, (2) the reduplication or reproduction of chromosomes, and (3) making them visible. Thymonucleic acid is obtained from desoxyribose, which is provided by the reduction of ribose nucleic acid. The latter is produced in the cytoplasm under the influence of histone.

During the resting stage, the nucleus contains a relatively small amount of thymonucleic acid, because at the end of mitosis most of the nucleic acid charge of the chromosomes is given up. There are chromosome regions (blocks of genes or even whole chromosomes) the function of which is the production of ribose nucleic acid through the formation of histone, which is normally collected and stored during the resting stage in the nucleolus. These chromosome or chromosome regions are designated as heterochromatic, to distinguish them from the euchromatic regions. It is known that the whole or part of the sex chromosomes in animals, the so-called 'inert', and '*B*' chromosomes in various organisms are heterochromatic. For a normal functioning of the cell a specific heterochromatin-euchromatin balance is required. Since the amount of nucleic acid and the rate of its production determine the frequency of division, the excess amount of nucleic acid present in the tumour[10] must be considered as the fundamental cause of increased division-rate and malignancy. Thus the quantitative change in the nucleic acid metabolism, indicated by chromosome behaviour, may be one of the most important differences which distinguish tumour cells from normal cells.

The incorrect balance between heterochromatin and euchromatin, that is, an increase in the nucleic acid supply, may be very slight, and result only in a shortening of the resting stage between two divisions. In this case, which may be considered as the first stage in the development of the tumour, the 'malignant' cell cannot be identified morphologically. The excess nucleic acid over the normal supply, however, besides reducing the resting period, will sooner or later have repercussions in chromosome behaviour. One of the most frequent failures in the mechanism of the division under such conditions is irregular segregation of chromosomes at anaphase, which secondarily leads to a further unbalance and increase in the nucleic acid supply within the cell. This will be manifested now by (1) abnormal chromosome behaviour and (2) by a change in the size and contents of the nucleolus. As a result of the excess amount of nucleic acid produced, the chromosomes become sticky because they are coated with fluid non-polymerized nucleic acid. Several other abnormalities such as those described above will also be exhibited by the chromosomes, and nuclear division will become so rapid that it will not always be followed by cell division. This may be considered as representing the second stage in tumour development.

The cells with a slight extra amount of nucleic acid are gradually replaced by cells with a much higher nucleic acid content. With this change the development and differentiation of the tumour arrives at the third and last stage. Abnormal chromosome behaviour and irregular division become very frequent. The tumour tissues contain a great number of large, giant polynucleate cells, and show widespread cellular degeneration.

These three stages of tumour-cell types have been identified in different tumours, as well as in the same tumour. It is concluded that these stages and intergradations are conditioned by the different increases in the nucleic acid supply within the cell. In most tumours the various cell-types showing differences in the amount of nucleic acid are present side by side. Data were also obtained which suggest that the various proportions of these types in the tumour may be used as a criterion of differentiation and degree of malignancy.

The question is how this excess of nucleic acid supply is brought about within a normal cell ? From genetical and cytological evidence it is known that the heterochromatic regions of chromosomes primarily concerned with nucleic acid synthesis can undergo spontaneous mutation and structural change more easily than other parts[11,12,13].

It is not improbable that the initial change in the nucleic acid metabolism is brought about by a gene mutation which may be assumed to have occurred in the region controlling nucleic acid supply either directly or indirectly. Thus a somatic mutation, as postulated by Lockhart-Mummery[14], would be responsible for the increased nucleic acid supply. The ultimate cause of such mutational change within a normal cell is not yet known. The cytological analysis reveals only the fact that in the tumour cell there is a disturbed nucleic acid metabolism.

Summary

Cytological analysis of tumour cells shows that all chromosome abnormalities and the increased rate of division itself can be explained by assuming that there is a quantitative change in the nucleic acid synthesis due to alteration in the heterochromatic region of the chromosomes[15].

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[1] The cytological analysis was made possible by the financial support of the British Empire Cancer Campaign, and by the generous help of the Holt Radium Institute, Manchester.

[2] A more detailed description will be given elsewhere.

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[15] Dr. T. Caspersson, using cytochemical methods, arrived at the same conclusion. His data indicate that "the heterochromatic section of the nucleus must play a very specific role in carcinogenesis" (personal communication).

NEWS and VIEWS

Dr. J. C. Willis, F.R.S.

DR. J. C. WILLIS, the well-known botanist, celebrated his seventy-fifth birthday on February 20. When Dr. Willis was appointed director of the Royal Botanic Gardens, Ceylon, in 1896, he not only developed the gardens to a high state of efficiency but he also began a very fruitful study of the flora of the island, coming for the first time in contact with a most interesting tropical flora. He began with the investigation of the Podostemaceæ, a group of highly modified type of flowering plants which grow on the waterworn rocks of rapidly flowing tropical streams in various parts of the world. When at Cambridge as personal assistant to Sir Francis Darwin, he had accepted with enthusiasm Darwin's doctrine of natural selection, but faced with the fact of numerous species of the same family living under practically similar conditions of life he began to question the Darwinian theory of evolution. Thus the views which he has put forward in his later stimulating books had their origin in his intensive study of the Podostemaceæ.

Dr. Willis's studies of the endemic plants of Ceylon, and later those of New Zealand, confirmed him in his conclusion, formulated in his earlier publications, that the older a species is the greater is its geographical distribution, and vice versa. This view was put forward at some length with numerous examples verified by himself in "Age and Area", published in 1922. As this book met with some criticism, Dr. Willis published in the following year a reply to criticism. Further studies on endemism and geographical distribution have occupied Dr. Willis's time and energy since then and two accounts of his work and his conclusions were given to the Linnean Society in 1936 and 1938 respectively. Advancing age has not diminished his output of important contributions to botanical science, and 1940 saw the publication of "The Course of Evolution by Differentiation or Divergent Mutation rather than by Selection", a book showing the vigour of his mind and summing up with a wealth of mature and critical judgment the arguments in favour of his conclusion. Marooned in Switzerland during the present War, he is still hard at work and last April (1942) he published an article in the *Proceedings of the Royal Society* indicating the kaleidoscopic manner in which the mutations referred to in his "Evolution of Plants" takes place. This publication may be taken as an instalment toward a projected volume on geographical distribution, the publication of which has been retarded by the difficulties caused by the War.

Post-War Commercial Air Transport

THE recent discussion in Parliament upon the necessity for making provision for the development of civil aviation in the immediate post-war period has aroused much interest in many different circles, political, commercial and technical. Mr. F. C. R. Jaques, of North Eastern Airways, Ltd., 31–32 Haymarket, S.W.1, has prepared a memorandum in which he endeavours to apply his experience in commercial air transport to the post-war problem. He suggests that much technical progress in design has been made, necessarily secret at present, that has improved performance, reduced the labour needed for construction, and simplified maintenance. This should be reflected in a general lowering of costs of air transport, the principal bugbear of the earlier air-line operator. If schemes, both for commercial air transport and private flying, are launched with sufficient vision and energy they will help in the problem of re-establishing the skilled personnel of the R.A.F. in civil life.

The memorandum postulates that international freedom of the air is a necessary preliminary for the fullest development of civil flying, and suggests that sufficient balance can be maintained if each country controls its nationals, guaranteeing their bona fides, technical skill, and the airworthiness of their machines. These standards will obviously need to be aligned, at least approximately, by some international agreement. As such did exist before the War there should be no difficulty in resurrecting them. His suggestions include the removal of civil aviation from the Air Ministry, introducing a sense of competition in the air transport world by allowing other selected companies to operate, the development of internal routes possibly by smaller companies as feeders to the big transcontinental lines, and the immediate appointment of a powerful committee to examine such questions.

René-Just Haüy (1743–1822)

ON February 28 occurs the bicentenary of René-Just Haüy, recognized everywhere as the founder of the science of crystallography. Born in the small town of St. Just, in the Department of Oise, he was the son of a weaver, but in spite of his poor circumstances gained admission to the College of Navarre, in Paris, and at the age of twenty began to teach there. Led to the study of minerals through an accident with a crystal of calcareous spar, he discovered the law of crystallization, and became widely known thereby. In 1783, at the age of forty, he was elected to the Academy of Sciences, and in the following year he published his "Essay in the Structure of Crystals", the first of his various books. He was deprived of his posts at the Revolution, and for a short time imprisoned; but after the fall of Robespierre, he took his place among his scientific peers, being given a chair in the short-lived Normal School, and a seat in the Institute. He was also made keeper of the mineralogical collections at the School of Mines and secretary to the Commission of Weights and Measures. In 1802 he became professor of mineralogy in the Natural History Museum, where his lectures attracted large audiences. His numerous memoirs are to be found in the periodicals of the time. He continued to lecture to an advanced age, and died in Paris on June 3, 1822. His collections and his statue are in the galleries at the Museum, and on November 8, 1903, a monument to him and his brother, Valentin Haüy (1745–1822), a pioneer in work for the blind, was unveiled at St. Just, when a discourse was pronounced by Lacroix. The *American Mineralogist* (No. 6, 3, 1919) contains a series of articles on aspects of Haüy's life and works and includes a number of portraits.

British Mammals in War-time

THE increase of many species of British birds due to war-time changes in the countryside has already been noted in NATURE. Evidence is now accumulating to show that many British mammals are likewise increasing, and one of the most welcome is the pine-marten, which had reached a dangerously low population in many districts. Reports were recently made of its presence in North Wales at Bettws-y-Coed (*Field*, Jan. 1943), and in Scotland in the Forestry Commission and deer forest areas of the Highlands and in a cairn in the Grampians (H. M. Batten, *Scotsman*, Jan. 30, 1943). In Lakeland it has recently been reported from Ennerdale. The polecat is also increasing in the wilder parts of Great Britain. Foxes have increased at an alarming rate in most parts, even where there were no organized hunts as in Lancashire, while in Lakeland, where the Eskdale Hunt killed a record total of sixty foxes in January, there is considerable controversy over organized fox hunts.

The Scottish mountain hare, which inhabits only a few parts of the Pennines at Penistone above Sheffield, has wandered from the Cheviots, where it is plentiful, to inhabit some of the moors on the extreme northern fringe of Cumberland above Gilsland and Bewcastle. The increase of stoats, weasels and badgers is of considerable agricultural value, because rabbits form such a large part of the food of stoats and badgers, and weasels feed mainly on field mice. The increase of foxes is responsible as much as is trapping for the reduction of rabbits, which form the chief food of foxes, but their depredations upon poultry have necessitated a campaign against them.

A Laboratory in Physical Geography

A development in geographical research and teaching is the subject of an article in the *Geographical Journal* of November–December by Prof. F. Debenham, in which he describes the laboratory for physical geography which he has planned and equipped at Cambridge, even though the exigencies of the times have necessitated its temporary dismantlement. The object of the laboratory is to study field processes, usually in miniature, under conditions of close observation and control with the view of ascertaining their mechanism, stages and effect. An amazing array of apparatus has been crowded into one room barely 50 ft. long by 19 ft. broad. In the wave trough, waves are generated by various methods and ingenious devices allow the measurement of period, height, length, etc. Here also beach building with sand and shingle can be studied. The wave tank, on a smaller scale, provides, among other aims, for the study of land forms produced by long-shore drift. An even more ambitious piece of apparatus is the tidal tank in which the difficulties of producing tidal currents seem to have been overcome, and good results are expected. The stream flume or delta tank seems to work well in the study of alluvial deposition, and the stream curve apparatus is to be used for the investigation of water movement in the bed of a stream. Other problems, too, are to be studied, and the whole laboratory is a promising step in the introduction of quantitative methods in the problems of physical geography.

Public Library of South Australia

The first report of the Public Library of South Australia, which was formed under the Libraries and Institutes Act, 1939, creating a Libraries Department under a Libraries Board of South Australia, with a Principal Librarian as administrative head, covers the half-year ending June 1940, and stresses the need for the permanent allocation of sufficient land for the natural growth of such an essential service. The various properties of the Public Library, the Museum and the Art Gallery have now been re-allocated, but despite adaptations the accommodation for library work, particularly for staff and for the country lending service, is entirely inadequate. War conditions have not affected adversely the use made of the Library, as is shown by an increase in readers of more than 7,000 during the year, and the Library staff has been taxed to its utmost to provide information regarding all sorts of conditions arising from the War. Financial provision for books is still inadequate and the Board has recommended the establishment of a research department for handling requests for scientific, technical and economic information. For this a more extensive range of periodicals is urgently required. The country lending service has also been called upon for books beyond the limit of its capacity, and its work has grown so rapidly that early extension of accommodation is necessary to provide adequate working space. The Archives Department has reached the limit of its shelving accommodation and offers of many important series of documents, arising from the present extensive pulping of old records, cannot be accepted because of lack of accommodation.

Joints in Submarine Cables

R. Miller and C. T. Rose contribute an article on this subject in the Engineering Supplement of *Siemens Magazine* (Oct.–Nov., 1942). In submarine cables particular care has always to be exercised in dealing with the joints, and every endeavour is made to limit their number by manufacturing individual cable lengths as long as possible, consistent with the methods of transport, storage accommodation, etc., available, and the scheme of laying to be adopted. With submarine cable-laying under normal conditions, it is unlikely that more than one sea joint will be necessary, the cable being laid in two parts, one section from each shore termination. This necessitates cutting the cable at a convenient position, buoying the end, and picking up again after the other section has been laid. The joint is then made on the ship and on completion is cast overboard, after due precautions have been taken. The article refers to both communication cables and power cables, the latter for voltages, for example, up to 33 kV. In the section on communication cables the authors discuss gutta-percha joints, splicing the sheathing wires, rubber joints, rubber to gutta-percha joints, and paper joints. The section on power cables is confined to those of the impregnated paper-insulated and lead-covered types and describes the making of subaqueous joints, super-tension joints and the handling of the shore ends of the cable. The article is illustrated and several photographs are included showing different stages in the operations of laying submarine cables.

Conference of X-Ray Analysis

The analysis of substances and the examination of their behaviour by X-ray diffraction methods has become of considerable importance in the war effort. The Institute of Physics is therefore arranging a second conference on the subject to take place in Cambridge during April 9–10. The provisional programme includes a lecture on "Future Developments in X-Ray Crystallography" by Prof. J. D. Bernal, and discussions on "Quantitative Treatment of

Powder Photographs", "The Fine Structure of X-Ray Diffraction" and "Line Broadening". A report is to be presented to the Conference on the progress made in the preparation of an index to X-ray diffraction photographs, for which the Institute has undertaken to be jointly responsible with the American Society for Testing Materials and the American Society for X-Ray and Electron Diffraction. Further particulars of the Conference and of the Index can be obtained from the Secretary of the Institute of Physics (temporary address: at the University, Reading).

The Night Sky in March

New moon occurs on March 6d. 10h. 34m. U.T., and full moon on March 21d. 22h. 08m. Conjunctions with the moon are as follows: March 3d. 03h., Mars 3° S.; March 4d. 19h., Mercury 2° S.; March 8d. 08h., Venus 3° N.; March 12d. 11h., Saturn 4° N.; March 15d. 18h., Jupiter 4° N.; March 31d. 22h., Mars 2° S. Occultations of stars brighter than magnitude 6 are as follows: March 12d. 16h. 40·2m., α Tauri (*D*); March 12d. 17h. 51·8s., α Tauri (*R*); March 17d. 22h. 43s., o^1 Cancri (*D*); March 17d. 23h. 03m., o^2 Cancri (*D*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance respectively. Mercury is a morning star at the beginning of the month. Venus is a conspicuous evening star and sets about 2h. 40m. after the sun in the middle of the month. Jupiter souths at 19h. 36m. in the middle of the month and is visible for the greater part of the night. Saturn is becoming an evening star and sets about midnight towards the end of the month. Vernal equinox commences on March 21d. 12h.

Comet Whipple will probably still be visible through a small telescope. An ephemeris is given below.

	R.A.				
Date 1943	h.	m.	Dec.	ρ	r
March 1	12	11·2	+ 55·2°	0·532	1·392
5		19·1	54·8	·552	·407
9		25·3	54·1	·574	·424
13		31·2	53·2	·597	·443
17		35·5	52·3	·620	·464
21		38·4	51·0	·647	·487
25		41·2	49·7	·674	·512
29		43·8	48·3	·703	·539

Announcements

The War Office announces that in deference to a request from the Lord President of the Council, it has been agreed that Sir Charles Darwin, scientific adviser to the Army Council, shall return to his duties as director of the National Physical Laboratory on March 1. He will be succeeded as scientific adviser by Prof. C. D. Ellis, Wheatstone professor of physics, King's College, London, who has been serving as deputy scientific adviser.

Prof. F. C. Lea, emeritus professor of engineering in the University of Sheffield, has been elected president of the Institution of Mechanical Engineers.

Sound films of honorary members and Faraday medallists of the Institution of Electrical Engineers are being shown before the Institution as follows: March 4: Sir J. J. Thomson and Lord Rutherford; April 1: Sir Ambrose Fleming and Dr. A. E. Kennelly; April 29: Lord Hirst and Dr. F. B. Jewett. Each meeting will be at 5 p.m.

The Herbert Jackson Prize for 1942 of the London Midland and Scottish Railway has been awarded to Mr. J. Dearden, of the Metallurgical Section of the Railway's Research Department, for papers entitled "The Inspection of Welded Steel Joints in Relation to their Static Mechanical Strength" and "The Influence of Welding Defects on the Resistance to Fatigue of Welded Steel Joints".

The third Pan-American Congress of Endocrinology will be held at Buenos Aires during July 1–6, when discussions will be held on the endocrine factors in diabetes, gonadotropism and the suprarenal cortex. Further information can be obtained from the Office of the Congress, Córdoba 2122, Buenos Aires.

The British Laboratory Ware Association, Ltd., has recently formed a technical committee, the objects of which are as follows: (1) To promote closer co-operation between bodies responsible for the design of standard laboratory instruments and apparatus and the manufacture of same. (2) To assist in rationalization of the design of apparatus and to eliminate overlapping, with the aim of securing economical production. (3) Collaboration to these ends with standardizing authorities, research associations, etc., in the drafting of specifications. It is hoped that research and other associations will avail themselves of the facilities offered in order that improved service and quality may result to users of the apparatus. All communications should be addressed to the secretary of the Technical Committee, British Laboratory Ware Association, Ltd., 73 Basinghall Street, London, E.C.2.

We have received a copy of the catalogue entitled "Medical Miscellany Lot 'G' ", published by Schuman's, 20 East 70th Street, New York, of which the special feature is an extensive section on psychiatry and neurology. Among these mention may be made of the following works: Esquirol's "Mental Diseases in relation to Medicine, Hygiene and Medical Jurisprudence" (first French edition, 1838), Griesinger's "Mental Pathology and Therapeutics" (Sydenham Society, 1867), Charcot's "Diseases of the Nervous System" (New Sydenham Society, 1877–89), Ramon y Cajal's "Structure of the Optic Chiasma" (first German edition, 1899), and Freud's "Three Contributions to the Sexual Theory" (first English edition, 1916). Other interesting works contained in the catalogue are Fracastoro's "Poem on Syphilis" (Latin text and French translation, 1753), the "Genuine Works of Hippocrates" (Sydenham Society, 1849), Hirsch's "Handbook of Geographical and Historical Pathology" (New Sydenham Society, 1883–86), and Hirsch's "Biographisches Lexikon" (second edition, 1929–35).

Erratum. In Nature of February 20, p. 219, paragraphs on "Science and Government" and "Parliamentary and Scientific Committee", reference was made to the "scientific advisers to the Ministry of Supply"; it should have read "scientific advisers to the Minister of Production", as is indicated on the chart on p. 206.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Simple Method of Demonstrating the Circular Polarization of Ionospherically Reflected Radio Waves

Since the ionosphere is a doubly refracting medium, due to the influence of the earth's magnetic field, a plane-polarized radio wave incident normally on it is split into two elliptically polarized components of opposite rotational sense. For a certain range of frequencies, in the neighbourhood of the gyro-frequency, only one of these two components is reflected in strength, the other being strongly absorbed. In northern temperate latitudes this reflected component is of left-handed, approximately circular, polarization. In corresponding latitudes in the southern hemisphere the sense of the polarization is reversed.

To demonstrate the circular polarization of ionospherically reflected waves in such cases it is necessary to show that the two components of the magnetic vector along the two axes Ox and Oy in the ground plan are equal and are 90° out of phase. (See Fig. 1, where the direction of propagation of the downcoming waves is supposed to be normally into the paper.) If two equal loop aerials are placed with their axes along these directions, the electromotive forces in these aerials will have the same phase difference as the magnetic vector components; but to exhibit the value of this quantity on a cathode-ray oscillograph requires both pulse transmissions and elaborate receiving equipment in the form of two high-frequency amplifiers of exactly similar phase and amplitude characteristics.

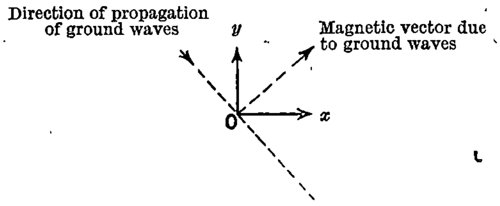
Direction of propagation of ground waves
y
Magnetic vector due to ground waves
O
x

Fig. 1.

It is, however, possible to demonstrate this phase difference in a much simpler manner. Let us suppose that the incoming signal is caused to beat with a locally produced oscillation, the frequency of which is very slightly less than that of the downcoming waves. Low-frequency beats can then be obtained from the signals in the two aerials, and it may be shown that the phase difference of the two beat envelopes is then exactly the same as that of the two high-frequency components under examination in the two aerials.

To produce the required low-frequency beats it is not necessary to provide a separate heterodyne, since the oscillations produced by the ground waves answer the same purpose. During the early morning when the height of ionospheric reflection is being slowly reduced, under the increasing solar influence, the frequency of the reflected waves is slightly higher than that of the ground waves due to Doppler effect. The variations which then take place in the outputs from the two aerials are due to the beats between ground and ionospherically reflected waves, and the phase difference we seek to demonstrate is equal to that between the signal variations in the two systems. If we set the two loops at 45° to the directions of propagation of the ground waves, we ensure that the ground waves have equal influence on both systems, and, if each aerial is provided with a rectifier and recording galvanometer, the relative magnitudes of the fading depths and the phase difference between the fading cycles can be simply demonstrated.

With waves of frequency of 2–3 Mc./s., the early morning fading is usually quite regular and the two records are similar to those shown in Fig. 2. It will be seen that the vector along Ox leads that along Oy by 90° and this, together with the fact that the fading is of equal depth in the two cases, shows that the downcoming wave is of left-handed circular polarization.

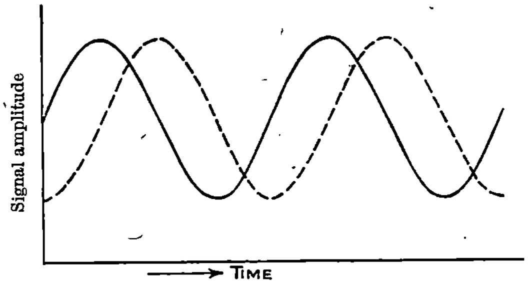

Fig. 2. THE FULL LINE REPRESENTS THE SIGNAL VARIATIONS IN THE LOOP WITH AXIS Ox; THE DOTTED LINE THOSE IN THE LOOP WITH AXIS Oy.

In the case of observations made in the evening (for example, on medium wave broadcasting stations) the ionospheric height of reflection is increasing, and the frequency of the down-coming waves is therefore slightly less than that of the ground wave. The phase difference between the beats as produced with a common heterodyne (that is, the ground wave) is then shown by the examination of the fading curves read in the *negative* direction along the time axis, since the beat notes are then reversed in phase relative to the original signals.

Edward V. Appleton.

Department of Scientific and
Industrial Research,
Teddington.

Feb. 2.

Absolute X-ray Wave-lengths

An important discrepancy is beginning to make itself felt in X-ray diffraction measurements. At present, lattice spacings of crystals are based on the Siegbahn X-unit[1], which is defined as 1/2814·00 of the 200 spacing of rocksalt; this definition made the X-unit as near as possible to 10^{-3} A., in the light of the then-known value for Avogadro's number, N_0. Such a standard was necessary because relative measurements of wave-lengths could be made much more accurately than absolute ones.

So long as the same value of N_0 was used both to specify the scale of X-ray wave-lengths and to work out the contents of a unit cell, no important errors could arise. Now, however, the accepted value of

Avogadro's number[2] has been decreased by about 0·6 per cent from the value on which the X-unit was based. The new value is derived from the measurement of the density and unit cell of calcite[3], the wave-length of the X-rays used being determined on an absolute scale by diffraction from a ruled grating. The error is equivalent to the statement that the X-unit differs from 10^{-3} A. by 0·2 per cent. Therefore, if the new value of N_0 be accepted, one cannot use the Siegbahn scale of wave-lengths.

The formula for the number of molecules, n, in a unit cell is

$$n = \frac{N_0 \rho V}{M},$$

where ρ is the density, V is the volume of the cell, and M is the molecular weight. There are two ways of evaluating correctly n, M or ρ from this equation.

(1) The most recent value of N_0, 6·0228 (±0·0011) × 10^{23} mole^{-1}, may be used, and V expressed in A.[3], that is, in absolute units. In order to derive the lattice constants the X-ray wave-lengths used must be corrected from the Siegbahn scale; some examples of the necessary changes are shown in the accompanying table.

		X-units	Ångström units
	$K\alpha_1$	1537·395	1·540522
Cu	$K\alpha_2$	1541·232	1·544367
	$K\alpha$ (weighted mean)	1538·7	1·5418
	$K\beta_1$	1389·35	1·39218
	$K\alpha_1$	707·831	0·709271
Mo	$K\alpha_2$	712·105	0·713553
	$K\alpha$ (weighted mean)	709·26	0·71070
	$K\beta_1$	630·978	0·632261

(2) If one wishes to retain the Siegbahn scale, one must use an arbitrary value of N_0, namely, 6·060 × 10^{23} mole^{-1}. In this case the lattice constants are in 1,000 X-units, although it is an invariable practice to call them Ångström units.

An error of the order of 0·6 per cent will occur if the new value of N_0 is used with the Siegbahn wave-lengths; this may be quite considerable if substances of high molecular weight are being studied.

The question arises as to which is the better of the two procedures. There is no doubt that the more logical is the former, in which case all wave-lengths need to be converted to Ångström units by multiplying the X-values by $1·00203_4 \times 10^{-3}$, the conversion factor given by Bearden[4]. There are two main obections to this. First, there may be some confusion during the change. Warren[5] has suggested that this confusion would be lessened by using the symbol AA' to express 'absolute Ångström units'. Secondly, the conversion factor is still not known so accurately as are the relative wave-lengths, and so another adjustment may have to be made later. The relative wave-lengths are known probably to 0·001 per cent; and though Bearden is of the opinion that the conversion factor is also known to 0·001 per cent, Birge puts the error much higher, namely, 0·006 per cent. It might thus be thought preferable to wait until the conversion factor is known more accurately. It is possible, however, that no great improvement in accuracy can be expected with present techniques, n which case there would be no point in delay on his account.

Our own opinion, and that of the members of this laboratory with whom we have discussed the matter, s that the new wave-lengths should be adopted; nd it is hoped to get a more general opinion at the second X-Ray Conference of the Institute of Physics o be held in Cambridge in April. We should, however, be glad to know the opinions of others who may be interested in the question, and whose results may be affected by it.

H. LIPSON.
D. P. RILEY.

Cavendish Laboratory,
Cambridge.
Feb. 9.

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Penillic Acid, an Optically Active Acid from Penicillin

WE have observed that when highly active penicillin preparations are kept in aqueous solution at pH 2 there occurs a rise in the optical rotation which reaches a maximum and there remains constant. After this treatment only part of the material formerly readily extractable by ether can be removed by this solvent and there is left in the colourless aqueous phase a substance which is strongly dextro-rotatory and has a pale bluish fluorescence in ultra-violet light. This substance, which we have named *penillic acid*, can be extracted from the aqueous solution by butyl alcohol, from which it can be separated in crystalline condition. Penillic acid has been obtained in this way from barium penicillin preparation varying in activity from 300 units to 1,200 units per mgm., and as the yield is directly proportional to the biological activity of the penicillin used it seems not unlikely that penillic acid is derived from penicillin itself and not from its concomitants. The best yield so far obtained amounts to 20 per cent of the barium penicillin.

Penillic acid crystallizes from water in brilliant rhombs or in hexagonal plates which decompose at about 175° with evolution of gas but without charring. In aqueous solution ($c = 0·2$) it has the high specific rotation of + 600° for the mercury green line. The solution of the recrystallized material shows the pale bluish fluorescence referred to above. It is acid to litmus and has some of the properties of an amino-acid. It gives a deep bluish-purple colour with ninhydrin and is precipitated by mercuric chloride and phosphotungstic acid. It forms a sparingly soluble silver salt. It readily decolourizes bromine water without formation of a precipitate. It does not give the blue colour with ferric chloride characteristic of penicillamine[1].

The penicillin used in these experiments was purified by the silica gel – barium carbonate column recently described by Catch, Cook and Heilbron[2] from penicillin kindly supplied by Dr. C. G. Pope, of the Wellcome Physiological Research Laboratories, to whom we make grateful acknowledgment.

The work described above was carried out under the auspices of the Therapeutic Research Corporation of Great Britain, Ltd.

W. M. DUFFIN.
S. SMITH.

Wellcome Chemical Research Laboratories,
Beckenham.
Feb. 15.

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Linkage of Physico-Chemical Processes in Biological Systems

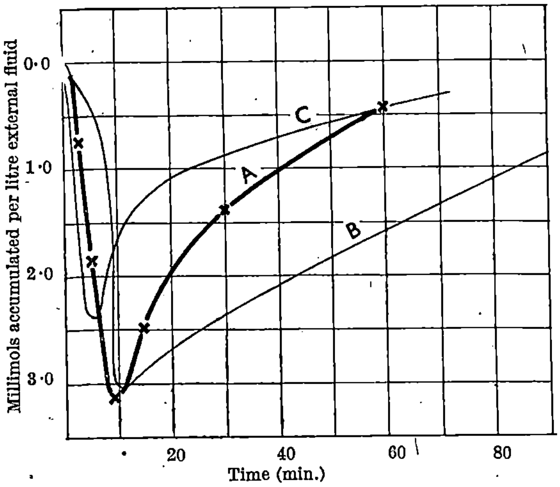
IN a recent communication in NATURE[1], it was pointed out that the shift of equilibrium between extracellular and intracellular potassium during fermentation of sugar either by yeast or bacteria[2,3], was a striking example of the general application of certain principles underlying the accumulation of potassium in cells[4,5,6,7]. If our views as to the nature of such in and out movement during fermentation are correct, it should occur with other cations besides the potassium ion, provided they can diffuse across the cell membrane, or in other words, it should not be *specific* for potassium.

Such another cation is ammonium, and we have recently found that a shift of the ammonium ion occurs in 'ammonia' yeast just as it occurs in 'potassium' yeast.

The 'ammonia' yeast was formed by replacing all the potassium in ordinary baker's yeast in the manner previously described[8], the concentration of the external ammonium being $N/5$ and the process hastened by maintaining at 37° C. The concentration of potassium in such 'ammonia' yeast was much less than 1 mgm. K/100 gm. Yeast so treated was then washed a few times with 0·3 per cent sodium chloride, and left for some hours suspended in this solution, when the external ammonium ion concentration was about 20 mgm./100 ml. To a measured volume of this yeast suspension (1 in 3) was added a small amount of a concentrated solution of glucose and sodium acid phosphate to produce 1·4 per cent glucose in the mixture and $M/140$ phosphate, and to an equal volume of the yeast suspension the same addition was made but without the glucose. The ammonia content of the external solution was examined after varying times, and the values for the mixture containing glucose subtracted from the control figures, giving in one typical example curve *A* in the accompanying graph, which is compared with the curves of K accumulation, *B* and *C*, of Pulver and Verzar[2] with yeast (second experiment in their paper), and of Leibowitz and Kupermintz[3] for bacteria (*E. coli*). Similar curves for 'ammonia' yeast were also obtained in repeat experiments on the same yeast where glucose in saline was added to the mixture from which glucose had disappeared by fermentation, and saline to the control mixture.

This movement of potassium and ammonium ions is in itself to be differentiated from possible specific effects of the ions on yeast activity or that of yeast extracts. For this there is an extensive literature. A short review is given, for example, by Stavely *et al.* in their first paper on zymin[8]. From a recent communication in NATURE[9], Farmer and Jones appear to have obtained some new evidence in this field.

The explanation previously given of the potassium shift during fermentation, which now extends to a similar ammonium shift, would appear quite satisfactory, and relates to those principles which are fundamental to the accumulation of potassium in cells[4-7]. The ion movement would appear to be controlled by the effective product of the free phosphate and potassium (or ammonium) ion concentrations (free phosphate being present mainly as the univalent ion at the pH obtaining within and without the cells). When glucose diffuses into the cells, there is a very rapid formation of glycogen, according to Willstätter and Rohdewald[10]. In the first two minutes, 90–100 per cent of glucose which has diffused in is present as glycogen. This stage is rapidly followed by a marked increase of phosphate esters formed from the glycogen. In the present explanation it is then supposed that the product of the potassium (or ammonium) and phosphate ion concentrations falls steeply and phosphate ions enter with K (or NH_4), the diffusible cations being held within by the electrostatic attraction of the newly formed non-diffusible ions. When these are broken down again the process is reversed, and K (or NH_4) leaves the cells.



This explanation does not imply that there is a simple equality of concentration products within and without the cell, as would be considered for a Donnan equilibrium of the simplified kind for very dilute solutions, for, apart from the effect of the total ionic concentration, the yeast cell membrane is practically non-distensile and the internal pressures are likely to be very much different from those without, with corresponding alteration of the ion activities; but it does imply that an equilibrium will occur with a definite ratio of the products of the ion concentrations (probably not far from unity) and that a change in this ratio will influence the movements of the ions in the direction of its restoration.

Further work on this question is in progress, being assisted by a grant to one of us from the Irish Medical Research Council.

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Mechanism of Lysis of Red Blood Cells

STUDY of the etiology of blackwater fever has le us to examine the wider problem of the mechanism of red cell destruction in the body. A summary o the preliminary work and the conclusions reached i given below.

We have observed that certain tissues (lung, liver kidney, spleen, bone marrow and muscle) will lys saline suspensions of washed red blood cells. This lysis is observed consistently only if the tissues are themselves first thoroughly washed or rinsed in saline. On the other hand, tissue slices have little or no lytic effect on suspensions of unwashed red cells.

Inhibition of this lysis is produced by: (*a*) The addition of the animal's serum to the mixture of tissue plus red cell suspension. This inhibitory effect of serum is not confined to the animal's own species, but can be produced by the exhibition of sera of other species. The inhibitory effect of heterologous sera is, however, observable only in a definite zone of dilution. This is particularly noticeable in the case of human serum, which in low dilutions has been found to lyse guinea pig red cells even in the absence of washed tissue. (*b*) The addition of sodium cyanide in a dilution of as little as 1 in 20,000,000 and of mercuric chloride in a dilution of 1 in 32,000. (*c*) Heating the tissue to a temperature of 80° C. or above for a period long enough to affect all the tissue used in the experiment.

Species used in these experiments have been man, monkeys (Cercopithecus, Erythrocebus, Colobus) and guinea pig. So far as our experiments have gone, the lytic agent appears to be species specific, while the serum inhibitor is not.

Consistent results have been obtained with guinea pig tissue, using washed guinea pig lung as the lytic agent and a 5 per cent physiological saline suspension of guinea pig red cells, washed three times in physiological saline, with or without the addition of 5 per cent glucose.

In the uninhibited red cell suspension – washed tissue system, lysis is completed in 18–24 hours.

The strictest aseptic technique must be employed throughout these experiments. It is essential that all glassware should be scrupulously clean by chemical standards.

It is difficult to conceive that the lytic agent demonstrated by the above experiments can be other than an enzyme, although as yet we have been unable to perform the crucial respiratory experiments. If our contention is correct, there exists in the animal body an enzyme capable of destroying red cells. The activities of this agent are held in check by an inhibiting substance which is present in both the tissues and the blood serum. The degree of lysis occurring at any time in the animal body may thus depend upon the balance of inhibitor over lytic enzyme activity. Abnormal degrees of lysis such as those met in blackwater fever and other lytic anæmias may therefore be due either to interference with the activity of the inhibitor or to its actual destruction.

BRIAN MAEGRAITH.
G. M. FINDLAY.
N. H. MARTIN.

West African Force.
Dec. 21.

A New Land Nemertean

IN January 1938, Yngvar Hagen, zoologist of the Norwegian Scientific Expedition to Tristan da Cunha (1937–38), discovered a new nemertean species on Nightingale Island. The animal was found attached to the underside of boulder stones situated on a beach, though far above the high-water mark. The fauna of the area was quite a terrestrial one, as land snails, mites and spiders were also found there. The worm was later handed to me for a closer examination, and this investigation has now been finished. Publication of the paper must wait until after the War, but I should like nevertheless to place this interesting find on scientific record now.

The animal turned out to be a new species of terrestrial nemertean, belonging to the genus *Geonemertes* Semp., which I have called *Geonemertes nightingaleensis*, n. sp. The length varied from 3 to 29 mm. In colour it is olive-grey, with two broader black-brown dorsal stripes. Four eyes were found. The animal is characteristic in its lack of an accessory lateral nerve and a frontal organ, the cephalic gland, however, being well developed. The animal seems to be more closely related to *G. agricola* and *G. chalicophora* than to the other members of the genus.

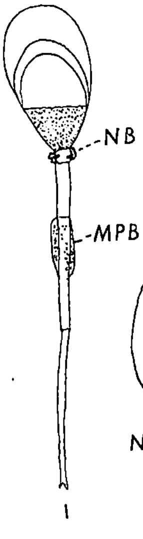
AUGUST BRINKMANN (jun.).

c/o Gothenburg Museum of Natural History,
Gothenburg.
Jan. 11.

Middle-Piece Beads in the Cavia Spermatozoon

IT is well known[1] that the silver nitrate methods of Da Fano, Cajal and Aoyama for the Golgi apparatus impregnate densely a bead just around the neck of the guinea pig sperm (Fig. 1, *NB*). It has been assumed that this bead is identical with the middle-piece bead depicted by Retzius[2] in so many kinds of mammalian spermatozoa.

We have recently been studying the spermatogenesis of the dog, and in trying to clear up some difficult points, we have reviewed the spermatogenesis of the cavy. We have been able to show that there are two beads on the spermatozoa from the epididymis, as shown in Fig. 1. The upper (*NB*) is extremely argentophile, and we have easily followed it back to the early spermatocyte in both the dog and the cavy (Fig. 3), as a vesicle almost invariably lying against the sphere (Golgi apparatus). The lower (*MPB*) is certainly the structure depicted by Retzius[2] (Taf. XLV, Fig. 3, etc.) and so far we have



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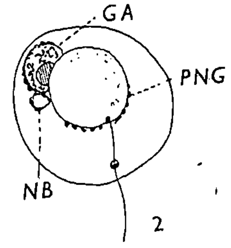

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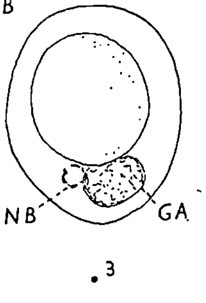

3

not found it on ripe spermatozoa within the testicular tubules. In such silver preparations as we have examined, it appears after the spermatozoa have entered the epididymis, and while it is generally found in the middle region of the middle-piece its position may vary. The position of the upper bead (*NB*) never varies, though its size may slightly. The material of the lower bead (*MPB*) assumes a brown colour on impregnation, like the secretion of the epididymis. More than this we cannot say at present.

On the point of the origin of the upper bead (*NB*) by budding from the Golgi apparatus remnant, as was previously believed by observers who have studied this matter, we cannot now support such an account. It is quite true that the bead (*NB*) is closely associated with the Golgi apparatus, before, during, and for a time after, the secretion of the acrosome (Fig. 2), so as to give the appearance of budding, but this view must be abandoned, since what is undoubtedly the same bead can be seen in the newly-formed spermatocyte and spermatid both in dog and cavy. It is interesting to note that the upper bead (*NB*) in the dog is very clearly formed of a vacuole and several separate argentophil elements. A similar structure was described in the human by one of us[3] some years ago, only in this case not so closely associated with the Golgi apparatus. Further work in the human is being undertaken in an endeavour to clear up this point.

J. Brontë Gatenby.
L. Collery.

Zoology Department,
Trinity College,
Dublin.
Jan. 18.

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The Countryside As It Was

In his notice of my book, "Field Fellowship", the reviewer makes certain animadversions on my "scientific accuracy". The issue over whole wheat flour is not one between white and brown bread but bread deprived of the wheat germ by the modern roller mills and bread which contains this nutritive essential. The "manchet" bread of the Middle Ages *was* white bread, but not faked bread. When it is considered that 26,000 of the stone-grinding country mills (which retain the wheat germ) have become derelict in Great Britain owing to the enormous powers exercised by the roller mill interest, it is scarcely surprising that the public have accepted the white bread of the latter. There has been virtually no alternative except by considerable trouble to find a stone-grinding mill and at the necessarily higher price. Eighteenth century white bread was of course never wheat-germless; the process of extraction had not yet been invented.

The reviewer says that the "village garage mechanic" is an adequate substitute for the demise of the rural craftsman. The whole point of rural industry as practised in Great Britain for at least three thousand years was its intimate association with, and dependence upon, agriculture. The garage mechanic has no such organic relationship with the land.

The mechanization of agriculture is and must be as a substitute for human labour. This is quintessential in war-time, but disastrous in peace, because it must necessarily increase unemployment at a time when the problem of employment is the most harassing that modern governments have to face. Also, the small farm can never be mechanized to the same extent as the large, so that the whole tendency of excess mechanization is the formation of "Latifundia", which experience has shown to be extremely deleterious to fertility.

The reason for "the intellectual stagnation" of village life in the past was the effect of the enclosures and the industrial revolution in breaking down the whole structure and pattern of country life. All the best blood was either transported to the Colonies or drawn off to the towns. The restoration, not the urbanization, of country life is surely the remedy.

H. J. Massingham.

Reddings,
Long Crendon, Bucks.

With regard to Mr. Massingham's first comment. The point made in the review was that the public had adopted the whiteness of the bread as their criterion of its desirability long before the roller mill was introduced, so that the roller millers cannot be accused of originating this criterion. They have never had to advertise "Eat Whiter Bread"; it is Mr. Massingham and the nutritional experts who have tried to persuade the public to "Eat off-white Bread", that is, stone ground or "manchet" bread, which the majority still prefer not to do.

The review did not pass judgment on whether any one village craftsman is an adequate substitute for any other. The point made was that new crafts are in fact springing up in the village. The good garage mechanic has often the same relation with the land as the village blacksmith. Neither are of the land, but it was the smith who enabled much of England to be brought under cultivation two thousand years ago. Was he an adequate substitute for the demise of the flint knappers?

Mr. Massingham makes three statements about mechanization. First, that it decreases employment. This statement depends entirely on economic policy, for before the War many farmers actually increased the number of men employed when they turned to mechanization, as they could then intensify their agriculture. Secondly, that the small farm can never be mechanized to the same extent as the large. Categorical statements about future developments can rarely be statements of fact, so that Mr. Massingham must allow me to part company with him here, as pointed out in the review itself. Finally, he states that mechanization tends to the formation of "Latifundia", which are extremely deleterious to fertility. It is difficult to argue a point like this, owing to the vagueness of the word "Latifundia" applied to present-day conditions. There is no evidence that mechanization has yet increased the number of large farms, and, for reasons largely irrelevant in Great Britain, the trend of agricultural engineering development is towards small machines that can work irregularly shaped fields. The real flaw in Mr. Massingham's arguments is that he thinks of mechanization as applied to grain ranching only, which was the first but will not be the last set of agricultural operations to be completely mechanized. The marriage of the tractor to the dairy cow is rapidly taking place wherever agriculture is founded on Western European methods.

E. W. Russell.

Rothamsted Experimental Station.

NATIONAL RESEARCH COUNCIL OF CANADA

SCIENTIFIC research in Canada during the past three years has been directed almost wholly to the solution of new and urgent problems arising out of the War. The National Research Council is serving as a central co-ordinating body directing research within its own laboratories and in the universities and industry. The Council has been appointed the official research station of the Navy, Army and Air Force in Canada.

For the Navy

Scientific problems arising in connexion with the work of the Navy are studied jointly by officers from Naval Headquarters and civilian personnel on the Council's staff. The National Research Council maintains civilian scientific groups at several points on both the Atlantic and Pacific coasts who work in the closest co-operation with the Naval stations. A group is also located in Ottawa and contact is maintained with similar research stations in the United States and Great Britain.

Many of the problems presented relate to the supply of materials and the preparation of specifications. Highly technical problems have arisen from anti-submarine warfare and minesweeping operations. Several sections of the Division of Physics and Electrical Engineering are concerned almost exclusively with research and development programmes for the Royal Canadian Navy. In the Electrical Engineering Section a shock and vibration machine based on standard British Admiralty design has been installed. The specifications for building the machine were modified to permit the use of Canadian materials. This machine is used for testing resistance to shock of various electrical equipment, such as switches, rheostats, junction boxes, lighting fixtures used by Navy and merchant ships. From the results obtained specifications for all electrical equipment for the purposes enumerated are being developed as required. Problems investigated in the electrical engineering section have included studies of gear for magnetic minesweeping. A rocking machine to stimulate the rolling of a boat has been constructed, and tests of various instruments have been made on this unit.

In the Division of Chemistry many problems of interest to the Navy have been investigated. Work on paints, rubber, low-alloy high-strength steels and aluminium alloys, and sea-water resistance of various coatings and inhibition of corrosion of various metals by chemicals may be mentioned. In the Division of Mechanical Engineering, likewise, the several laboratories are engaged on numerous problems for the Navy, notably in matters relating to engines and their lubrication, the design and test of boats of various types.

For the Army

For the Army and also for the other Services all kinds of supplies have had to be tested to determine whether they are acceptable according to required military standards. Apparatus has been developed and constructed for work in ballistics on an increasing scale. Measuring equipment for ammunition proof and gun proof has been developed and is in continuous service at proving grounds. Problems on the direction of gun-fire have been attacked with success. Numerous tests have also been made on the armouring properties of various materials and work is in progress on the improvement of anti-aircraft projectiles.

An important war service was rendered in 1939 by promoting the development in Canada of optical glass manufacture for the production of precise optical parts for military equipment. The project is now being carried forward in production by a Government-owned company. Equipment was installed and a staff assembled in the National Research Laboratories for the inspection of gauges used in the production of guns, shells, fuses, bombs and other mechanical items which are now being made in mass production.

Another important activity of the Army which is built on science is chemical warfare. From a small co-operative effort between the National Research Council and the Army, this activity has developed rapidly and is now a highly co-ordinated project operating as a directorate of the Department of National Defence, but under a director-general who is a civilian scientific worker on the staff of the National Research Council. Of the active personnel about one half are civilian men of science and the rest are Service men.

Indicators for war gases and chemicals for other war services have been synthesized and studied. The rubber laboratory has investigated, for production purposes or improvements, products used by almost every branch of the Armed Forces, including surgeons' gloves, ground sheets, gas-mask components, artillery and tank parts, crash and steel helmets. In addition, the laboratory has made numerous acceptance tests on contract deliveries. Recently much attention has been given to rubber conservation problems and to the study of synthetic rubber processes. Commercial production of fuse-powder charcoal was carried on until recently by the National Research Council; manufacturing has now been turned over to a commercial concern. Research on the fundamental problems involved in the operation is being continued by the Council.

Activities in the textile laboratory have been largely in connexion with acceptance test work and specifications. Special problems included an investigation of methods to reduce weathering of canvas duck, a study of thermal transmission of blankets, colour analyses of certain types of textile products and work on respirator pads. Materials tested included felt, silk gauze, silk thread, braid, vulcanized cloth, box cloth and various types of uniform materials. A large amount of work is being carried out on the development of suitable types of anti-gas impermeable-type fabrics and on the maintenance of suitable standards of quality in material of the type which is being manufactured in Canada. Other studies include work on the water-proofing, mildew-proofing and flame-proofing of cotton textiles.

Inspections have been made and advice given as to the suitability of a variety of leathers for different military purposes. Examination has been made of numerous dressings and waterproofing compounds for leathers. Tensile-strength tests on leathers, and wear-resistance tests, chiefly on composition-sole materials, were carried out for the Department of National Defence. Used militia boots were examined for the cause of cracking in the vamps. Research on the deterioration of shoe uppers has been continued.

Component parts of certain anti-aircraft protection devices were constructed. Transparent sheet resins for military purposes have been tested against specifications; vulcanized fibre identification disks and other objects have been examined, and general consideration has been given to the substitution of plastics for metals in a number of articles and parts related to war materials.

Preservative coatings for use on military vehicles and other equipment for war purposes have been developed. A surprising variety of finishes is required in this field and many of the materials are comparatively new to Canadian industry. The laboratories have co-operated with Government authorities and manufacturers to facilitate the supply of these highly specialized coatings. Gas-detector paints, luminous paints, finishes for rifle barrels, camouflage paints and other special paints have been developed.

Mention should be made of the establishment of an explosives laboratory to carry out testing required under the Explosives Act and to conduct research on explosives and related compounds. This laboratory is under the joint administration of the National Research Council and the Department of Mines and Resources. An Associate Committee on Explosives has been established to co-ordinate and direct all work in this field.

For the Air Force

Establishment of the new aeronautical laboratories just outside Ottawa has provided improved facilities for research on the multitude of problems arising from modern trends in aviation. Closest co-operation is maintained between the Royal Canadian Air Force and the Council's laboratories through the Associate Committee on Aeronautical Research, the chairman of which is the Air Member for Aeronautical Engineering, R.C.A.F. Much of the work in progress relates to problems that have been suggested by Air Force authorities in Canada, the United Kingdom or the United States.

Horizontal and vertical wind tunnels are in use. In the engine laboratory dynamometer rooms are provided for the testing of aircraft engines, while in the gasoline and oil laboratory complete equipment is provided for physical and chemical testing of aviation fuels and lubricants. A structures laboratory provides for the fabrication of prototypes of aircraft and for the test of component parts.

Experimental work required in connexion with scientific problems under investigation in the National Research Laboratories is often carried out co-operatively with the Royal Canadian Air Force Test and Development Establishment, which is really a full-scale experimental flying station.

During the year the Radio Section continued to work on the development of secret radio locator equipment with considerable success. There are already in the hands of the Services numerous different equipments which have been developed in the National Research Laboratories. Some of these have already been used successfully against the enemy.

Medical Research

In the field of medical research an active committee of the Council has made great progress. The original purpose of this committee was to co-ordinate medical research in Canadian institutions and to assist in its development. The activities of this committee are now wholly directed to war problems. The work has grown to such an extent that several new sub-committees have had to be established to deal with questions of shock and blood substitutes, wound infection and surgical problems. Regional committees have been appointed to facilitate the work. Liaison with Great Britain and the United States has enabled Canada to co-operate effectively with them in the promotion of medical investigations arising from war problems. More recently, Australia and New Zealand have been included in the interchange of reports.

In the field of medical research as applied specifically to the Services, three associate committees are in operation dealing respectively with aviation, naval and army medical research problems.

The first of these associate committees, on aviation medical research, was formed early in 1940 and has carried out a most impressive programme of work, especially in the fields of high-altitude flying and protective clothing. The work of the Naval Committee has been directed to the improvement of innumerable factors effecting the efficiency of personnel on boats, and the Army deals with similar problems of Service men who have to operate in tanks and work under the innumerable special Service conditions attendant on modern warfare.

Research activities under these committees have been carried on at most of the universities of Canada and at the National Research Council, the Ontario Research Foundation and the clinical investigation units and other establishments of the Services. The close collaboration existing between the civilian and Service groups of workers and the help and advice so freely offered by industrial concerns have greatly accelerated the solution of a number of important problems.

For War Industries

The Division of Applied Biology has rendered valuable assistance in the fitting of temporary refrigerators on merchant vessels. The successful transport of perishable foodstuffs demands refrigerated shipping space or the conversion of the material to a less perishable form that can be carried in ordinary stowage. This problem is most acute for bacon, which goes forward in large volume. The shortage of refrigerated space has also affected other perishable commodities. Considerable work has been done on the treatment of shell eggs to avoid deterioration during shipment at ordinary temperatures. All export eggs, however, are now shipped in powder form, and the work of this group of investigators is therefore directed towards the development of methods for assessing quality and developing drying processes capable of producing a dried egg material of high quality.

Dehydration of meat, chiefly pork and cured ham has been studied, and an acceptable quality of product has been obtained. Closely related to food studies on products for shipments overseas is the development of containers in which a substitute for tin plate has been used. Packages based primarily on fibre and wax combinations have been found useful. Dehydrated products require packaging in waterproof materials.

The need for magnesium led to intensive research and resulted in the development of a process well suited to Canadian conditions of production. A plant of ten tons capacity per day, built by the Department of Munitions and Supply to use this process, is in operation, while plants totalling about a hundred tons per day capacity are being built in several centres in the United States.

The shortage of natural rubber, which is so important for military purposes in this age of mechanization, has stimulated research on the possibility of producing rubber from plants that can be grown on the American continent. Synthetic rubbers of various types are being developed and tested, and plants are being established for the production of the more useful types.

SCIENTIFIC PROGRESS SINCE 1840

In a lecture, "A Century of Progress: Men, Manners, Inventions", given before the Lancastrian Frankland Society on January 15, Dr. E. F. Armstrong drew a stimulating comparison between the conditions of Edward Frankland's early years in Lancaster and to-day. Referring to the encouragement which Frankland received from the Johnsons in Lancaster, who sent him to Playfair in 1845, Dr. Armstrong remarked that the energy to get on in spite of the most adverse and discouraging circumstances was characteristic of the 1840's. A deep interest in Nature and in intellectual matters was also widespread in the north of England during the Victorian period and led to the formation of many local societies, ranging from the mutual improvement societies of the chapels to the mechanics institutes and literary and scientific societies of the small towns and the philosophical societies of the large cities. These societies, which besides spreading knowledge gave inspiration to the younger members, persisted until improved communications, a multitude of technical journals and the spread of technical colleges drove most of them out of existence, although even now technical societies with local sections have a most important function.

Frankland apparently took up science as a career through his parents instilling a spirit of inquiry and the desire to find out things for oneself. Commenting on the fact that the period 1840–70 saw the birth and entry into the sciences of a great many men from very diverse walks of life, whose achievements have laid the foundations on which we are building to-day, Dr. Armstrong directed attention to the early life of austerity and struggle which developed their powers. Among these were James Dewar, Horace and Adrian Brown, Charles Lapworth, Richard Threlfall, Alfred Yarrow, Bates of Amazon fame, C. F. Cross, James Alfred Ewing, and H. B. Baker.

The chief characteristics of the last hundred years, Dr. Armstrong suggested, are the inventions and discoveries which have so markedly affected the material progress of the world that they may well be regarded as the seven modern wonders of the world, superseding the seven architectural wonders of the past. The first of these is pure water supply, in the provision of which Frankland himself played a large part. As a scientific member of the Royal Commission appointed in 1867, he found that the oxidation and destruction of the organic matters present in town drainage took place with extreme slowness, contrary to the previous belief. He found, on the other hand, that slow percolation through porous soil effected this oxidation and destruction with great rapidity. Frankland also improved the old and devised new methods of water analysis, and throughout his life took special interest in the water supply of London, while his son, Percy Frankland, took up the study of the biological aspects of the problem. Continuing this work, Sir A. C. Houston, the pioneer of systematic chlorination treatment on a large scale, was also responsible for the scientific application of bacteriology for improving and safeguarding the purity of water. Dr. Armstrong referred here to his previous suggestion that a tablet commemorating these achievements of Frankland should be placed on the great new dam across Hawes-water.

Second of the modern seven wonders, both in point of time and importance to pure water, must be ranked electricity, which from its gradual development, starting with its use in signalling by Cook and Wheatstone, with no encouragement by the State, has now become a major industry touching almost every home. The third wonder was the spinning of viscose or Rayon from wood, with the consequent revolution in women's dress. Even now we are only at the beginning, the newest of all these fibres being Nylon, a wholly synthetic fibre, built up as it were from carbon, water and air, with properties as good or better than those of silk spun by the silkworm.

The fourth and fifth wonders, the internal combustion engine and hydrocarbon oil, are so interdependent that they may well be considered together. Giving us speedy transport on land, on sea and in the air, they have made the world one community. Speedy travel has had great political repercussions; and no individual, community or nation can withdraw at will to a quiet corner to follow its own inclinations. The development of the internal combustion engine was based on progress in design correlated with progress in metallurgy, while the oil industry was providing raw materials for many diverse chemical operations and was destined to displace coal tar and coal as the world's most important basic raw material for chemical synthesis —probably with further effects on our own post-war economy following on those already involved in the displacement or disappearance of cheap coal.

Next among modern wonders came the radio, which is enabling all to lead a fuller and broader life. Its cultural and scientific significance is not yet fully appreciated, and despite its importance in war the future applications may be astounding. The last wonder, Dr. Armstrong said, was the plastics, of which the man in the street is as yet only dimly conscious, although they are destined to make life easier for us all, to provide objects of utility, and should also make artistic design and beauty available at prices diminishing rather than increasing. Finally, Dr. Armstrong pointed out that the satisfactory solution of the problems of society into which science enters will be based on moral influence, and our effectiveness will depend on the devotion, wisdom and goodwill which we bring to our task.

A SPREAD-SCALE RECORDER

In an article with this title (*Bell. Lab. Rec.*, 21, No. 3; November 1942) O. D. Engstrom points out that the transmission tolerances of telephone circuits have become more severe, requiring a corresponding improvement in measuring technique and equipment. When a telephone circuit had only a few amplifiers or other circuit units, each could be permitted a larger share of the total permissible distortion, and errors in measurement of 0·25 db. meant very little. With the present transmission systems requiring many more circuit units than the earlier systems, this situation has changed. More accurate and faster operating testing equipment has been required, and a recording transmission-measuring set was developed that covers the voice-frequency spectrum in a few minutes. As originally used, the chart of this recorder could be read to about 0·2 db., but for many present-day measurements this is not adequate, and a new 'spread-scale' recorder has been developed that can be read to 0·02 db.

For a transmission measurement, an adjustable-frequency oscillator is provided with a small synchronous motor that changes the output frequency continuously over the range from 200 to 3,500 cycles for each test. An equalizer and adjustable attenuator in the output of the oscillator maintain the output power constant at the desired level for the test. At the output of the circuit being measured is an I–U amplifier-rectifier that converts the received A.C. into D.C. for operating the recorder. A 500 cycle selective detector is employed to mark the chart at a point corresponding to a test frequency of 500 cycles, and this mark is used in placing the frequency ordinates on the chart. A biasing circuit was added as one of the changes required to produce the spread-scale characteristic.

To secure the added precision needed for a chart that is to be read to 0·02 db., certain other changes were made, including principally an increased voltage stability of the power supplies and an increased stability of the oscillator output and of the detector gain as the frequency varied over the test range. Steps taken to improve the circuit in these respects include the provision of a regulated plate-battery power supply for both the oscillator and the detector, storage battery for filament supply, the selection of quiet tubes, and special regulation for the oscillator output characteristics.

The circuit is calibrated by applying an input of 10 db. below 1 milliwatt to the amplifier-rectifier, and then adjusting the resistance in the circuit of the biasing battery until a mid-scale deflexion is obtained. When making a measurement of the transmission characteristic of a piece of equipment, it is then necessary to adjust the oscillator output so that the output of the equipment under test is 10 db. below 1 milliwatt at roughly the frequency of the mean attenuation. The dial of the oscillator is then set below the edge of the desired band, and the oscillator and recorder are both started. The article describes and illustrates the recorder and its performance characteristics in detail.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, February 27

Malacological Society (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting and Commemoration of the 50th Anniversary of the Society's Foundation.

Light Railway Transport League (at Fred Tallant Hall, Room J, Drummond Street, London, N.W.1), at 3 p.m.—Dr. Hugh Nicol: "A Scientist Looks at Transport".*

Monday, March 1

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Sir William Prince-Smith, Bart.: "An Industrialist's Views on Agriculture and its Future".

Tuesday, March 2

Manchester Literary and Philosophical Society (in the Geographical Department, The University, Manchester), at 5 p.m.—Prof. J. Kenner, F.R.S.: "Historical Method in Teaching Science".

Institute of Welding (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—A series of Papers on "Developments in Arc Welding Technique".

Wednesday, March 3

Royal Society of Arts (at John Adam Street, Adelphi, London W.C.2), at 1.45 p.m.—Dr. J. D. Robertson: "Calcium Metabolism in Health and Disease".

Physical Society (Colour Group) (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 2.30 p.m.—Third Annual General Meeting. At 3 p.m.—Mr. J. Guild: "The Significance and Limitations of the C.I.E. Standard Observer Tables"

Institute of Metals (at the Institution of Mechanical Engineers Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—35th Annual General Meeting. Dr. Harold Moore: "Co-operative Research in the Metal Industries".

Institution of Mechanical Engineers (Joint Meeting with the Iron and Steel Institute and the Institute of Metals) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr S. W. Smith: "The Life and Work of Sir William Chandler Roberts-Austen".

Thursday, March 4

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Sound Films of Honorary Members and Faraday Medallists—Sir J. J. Thomson, O.M., F.R.S. Lord Rutherford, O.M., F.R.S.

Friday, March 5

Royal Society of Arts (India and Burma Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Malcolm Darling: "The Indian Village and Democracy".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir John Russell, F.R.S.: "Restarting of Agriculture in Devastated Europe".

Saturday, March 6

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting. Prof. H. H. Read, F.R.S.: "Meditations on Granite" (Presidential Address).

Friday, March 5—Sunday, March 7

Institute of Industrial Administration (at the Waldorf Hotel Aldwych, London, W.C.2). Conference on "Training for Industrial Management".*

Friday, March 5

4.30 p.m.—Registration of Members.

Saturday, March 6

10 a.m.—Management and the Nation.
11.15 a.m.—Address by His Grace the Lord Archbishop of Canterbury.
12.30 p.m.—Management and Industry.
3 p.m.—External Training for Industry.
5.30 p.m.—Internal Training in Industry.

Sunday, March 7

10 a.m.—Management and the Board Room.
11.30 a.m.—Review of Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer-Instructor in Engineering Workshop Technology and Practice in the Bolton Municipal Technical College—The Director of Education, Education Offices, Nelson Square, Bolton (March 5).

Master to teach Mathematics and Science at the Bingley Technical School—The Divisional Educational Officer, Education Offices, Bingley, Yorks. (March 7).

Lecturer in Mechanical Engineering in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (March 9).

Lecturer of Textile Testing in the School of Textiles—The Principal, College of Technology and Commerce, Leicester (March 13).

Chair of Chemistry in the University College of North Wales—The Bursar and Acting Registrar, University College of North Wales, Bangor (April 3).

Assistant Field Officer (either sex) for Crop Investigations of Mineral Deficiencies—The Secretary, Research Station, East Malling Kent.

Assistant (woman) for the Strawberry Nuclear Stocks Scheme—The Secretary, Research Station, East Malling, Kent.

Technical Assistant (male or female) in the Department of Economics—The Secretary, South-Eastern Agricultural College, Wye, Kent.

Assistant Engineers for operation and maintenance of hydro-electric Public Supply Company, Nigerian Plateau—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Section D.553X, Alexandra House, Kingsway, London, W.C.2.

Lecturer in Mechanical Engineering—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

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INDUSTRY AND EDUCATION

NO one would doubt, even in normal times, that the relations between industry and education are of fundamental importance to the planning of our life as a nation. The War has heightened that importance. It has "already brought with it changes in the structure and working of industry, above all on the human side, much further-reaching than those which developed during the last war". That quotation occurs in a statement on "Industry and Education"* which has been issued as a result of a conference between educationists and industrialists held towards the end of last year, under the auspices of Nuffield College, Oxford.

We commend the statement to the careful consideration of our readers. It does not, as its authors are at pains to point out, pretend to anything which is to be regarded as a scheme—final, rounded and authoritative. It embodies suggestions, and the aim of submitting those suggestions has been to provoke discussion and "to test the degree of agreement which exists among our colleagues in industry, in the universities and technical colleges, and in other walks of life".

The statement opens by laying down the fact that, after the War, our hope for steady and speedy advancement in wealth and welfare depends upon the extent to which we are able "to produce efficiently and cheaply a wide range of goods for consumption overseas as well as at home". In other words, all plans for advancing our standards of living "must depend, in the last resort, on the efficiency of British production and on the ability of British industry to sell goods in the world market".

How is that to be done ? The call for "cheap production" is very often linked with an emphasis on the need for "cheap labour". Such a solution is dismissed at once. Any attempt to solve the problem on the basis of low-wage competition is bound, says the statement, to end in failure. We must, instead, look to the quality of our labour and to the "attitude towards production of individuals who comprise the labour force", for they are the vital factors in raising productivity to a satisfactory level. Labour which is badly paid and discontented is never really cheap.

To secure quality of labour a planned scheme of education is essential, and it is here that the statement is crystal clear in its view that, so far as those who leave school at the statutory age are concerned, industry does not ask that they shall have received any specific vocational preparation for the occupations they are about to enter. "Industry itself can best undertake the specific training of such entrants, or collaborate with educational agencies in providing it after they have left school." What is needed in the case of these young people, including those in junior technical and secondary schools, is a broadly non-vocational course. That does not mean to say that the curriculum in all these schools should follow precisely the same lines. It means that while the technical school can provide a curriculum "centring on basic mathematics and science but also paying due attention to English and to social subjects", in a senior or secondary school "the teaching of cultural subjects will be combined with an attempt to give every pupil a sufficient grounding in elementary mathematics and in the foundations of science". The intention, for all these pupils, is to secure the speaking and writing of good and exact English and "a clear understanding of the essential character and institutions of the society" in which they will later have to play their part. Nor are these things to be regarded as separate 'subjects'. They are to be regarded as integral to the whole course and should therefore permeate the teaching of all subjects.

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* Oxford University Press, 1943. 1s. net.

Even if that were accomplished, however, the statement recognizes there will still be those who may have no prospect of rising from the lower ranks of their vocations. These will include repetition workers and, although it is believed that "industry will need not less but more intelligence and adaptability as mechanisation makes further advances", it is vital to prevent that sense of thwartedness which is always a possible danger. To that end, employers should be prepared to grant these workers a dual road to self-development by broadening the avenues of advancement and by release for study not necessarily connected with their work. Who will not agree with the view that "It is no mean part of industry's responsibility to those whom it employs to ensure that both these ways of human progress shall be made broad and easy of access to all-comers" ?

But while those who enter industry after the statutory school-leaving age constitute the majority, there are two other groups of entrants to industry : those who remain at secondary or technical schools after the statutory leaving age but do not proceed to full-time courses at a university or technical college, and those who enter industry either directly after a full-time university or higher technical course, or after a further period of study or research following such a course.

In the case of those who enter from secondary schools a reform appears immediately necessary. It is that the course they follow should be complete in itself. What industry sees here is that at present such courses are too often devised primarily as a preparation for university courses which, in fact, are not likely to be pursued by the majority. But to attain that end "it is necessary to release the schools from thraldom to an examination system conceived too much under university influence, or rather from a standpoint which regards the school primarily as a place of preparation for university work". The technicalities are not argued, but we believe that the authors of the statement have put their fingers on a matter which is already receiving the attention of a very large number of educationists whose starting point has by no means been the same.

From these schools, again, industry asks for the broadest and deepest possible development of general intelligence and initiative, and a sound basis of general scientific and mathematical knowledge. It is just as contrary to the requirements of industry as it is to the balanced growth of the individual that there should be any premature specialization. The first essential is to make firm the foundations. When these pupils have entered industry there should be the widest possible opportunities for further education in all its phases.

The final group of entrants are those who come after full-time courses at a university or technical college. They are those who may be expected to be the main supply for the higher personnel of industry and for industrial research ; and it is in connexion with their case that the statement turns a critical eye upon university scholarship examinations. If premature specialization at school is bad, the present tendency for those scholarship examinations to be unduly specialized must be altered. The statement therefore strongly urges university authorities to insist on a firm grounding in mathematics and science rather than on a high standard of specialized knowledge. We agree. Specialization is essential in the higher ranges of knowledge, but it must rest upon a broad groundwork. There is little need to emphasize even the potential danger of a 'specialist' who lacks what is called a cultural background. The phrase savours sometimes of the cliché : but we know that, whatever else it may mean, it means the ability to appreciate the wide issues of industrial organization and policy, the place which industry occupies in the community and the processes of social as well as technological development. Without that ability specialization lacks also the "qualities of leadership, initiative and imagination".

We are all familiar with the need for closer contact between industry and the universities. The statement makes important suggestions in that direction. These include the use of the staffs of industrial research laboratories to give courses of lectures to university students, and the seconding of university teachers and research workers for periods of service with the research staffs attached to particular industries. Moreover, the movement to and fro between 'pure' and industrial research could be made a good deal easier. Adjustments would be necessary, of course. Salary structures and other conditions are different, but they could and should be arranged in order to secure the end in view.

The authors of the statement believe, as we believe, that industry has a right to a higher proportion of the best men from the universities. The claim, in our view, is soundly based. If national standards are to be improved, the need to harness scientific knowledge fully to the promotion of higher industrial productivity is imperative. We know the value of the work done in this connexion by the university appointments boards ; but we agree that it is not enough. For that reason we believe that the suggestion of carrying on and improving the work of the Central Register which the War has brought into being is a useful one. It would not replace or make unnecessary the closer contact between university teaching staffs and those who deal with recruitment of the higher personnel of industry ; but it would be an advance in the right direction.

So much for the universities. But anyone who knows the details of industrial personnel knows the tremendous contributions made by technical colleges.

It was to be expected, therefore, that the relationship between university and technical college should be raised in any document dealing with the flow of recruits to all parts of the industrial structure. Clearly a large expansion of technical education is indicated in the future, and the proposal that the higher forms of technical education should be concentrated in the universities was bound to be examined. We are glad to note that the statement strongly dissents from that proposal. The intention may be admirable, but we agree that it is quite impracticable to separate the higher from the less advanced forms of technical education, "or to bring within the existing universities the large numbers who need higher technical training of one sort or another". The statement, therefore, supports the idea which has sometimes been expressed as the development of universities and technical colleges as the "twin tops of the educational system". The statement does not use that phrase. Instead it uses the phrase "People's University", and suggests the "making of technical colleges and other institutions which suffer from a parallel isolation and incompleteness into the nuclei of a new type of people's colleges, equipped both to train students for a wide range of vocations and to play an active part in widening the sphere of adult education". That method, it is suggested, "offers by far the best hope of endowing higher technical education with that cultural quality in which it is now too often deficient, and of constituting it a school of personality and leadership as well as technical skill". We are by no means disposed to accept all the implications of that quotation, but we need not here indicate assumptions which seem to us to lack foundation. The main idea is that of the people's college, and with that we are in cordial agreement.

Let us note in conclusion a protest made quite early in the statement. It is against the bias of the educational system against entry into manual occupations. There can be no doubt that the move towards "directing boys who are above the average intelligence into non-manual work" exists, and we agree with the protest "except where the non-manual occupations are such as to call for a high degree of intelligence". That bias against manual occupations has not, however, appeared without some reason. We recall having directed attention in these columns to at least one reason. It was so far back as November 12, 1927. What was said then bears repetition now:

> "This fault of shaping the bright boy to the black suit was regarded as belonging to parents and teachers rather than to employers. But are parents and teachers to receive all the blame? Is it not generally true that difference of status exists? Is it not generally true that in times of bad trade it is the production side which suffers while the administrative side enjoys something very like permanence? Can the employer help to avoid this—a very real threat to the future and welfare of industry?"

With that in mind we direct special attention to the final passage of the statement we are noting. It is headed "The Need for Hope". It underlines the passage we have just quoted when it says: "To most workmen and to many technicians the supreme discouragement to the development and display of the higher faculties is the fear of unemployment. . . . Not one of the suggestions we have put forward will bear its full fruit unless this inhibiting tenor can be exorcised." Industry must be forward-looking and assured that it "will not be made the sport either of defective financial arrangements or of official timidity in facing fundamental economic problems". Men live and work happily when they have hope, and because of that we need not amplify further the quotations we have selected. If their main suggestions go unheeded, the rest of the statement might just as well not have been written.

COLLOIDAL AND AMORPHOUS MATERIALS

Industrial Chemistry of Colloidal and Amorphous Materials

By Prof. Warren K. Lewis, Lombard Squires and Dr. Geoffrey Broughton. Pp. xii+540. (New York: The Macmillan Company, 1942.) 5.50 dollars.

IT is related that Prof. Nernst was wont to refer to the science of colloids as *die trübe Wissenschaft* (the cloudy science). The innuendo implied in this witty remark was not without some justification at one time, but that day is long past. So great have been the advances made during the last thirty or forty years in the study of sols and gels, interfacial properties and actions, and the structure and behaviour of large molecules or micelles—from 'macro' to 'mega'—that colloid science with its many applications now occupies a position of great and growing importance, and can offer to the student of Nature not only a very large body of quantitatively well established and well correlated phenomena, but also a corresponding body of scientific principles and reasoning.

The present book, a most admirable one and unique in many respects, comes from the Chemical Engineering Department of the famous Massachusetts Institute of Technology, the senior author, Warren K. Lewis, being the well-known professor in that Department, an honorary member of the Institution of Chemical Engineers (Great Britain), and long known throughout the world to students of chemistry as one of the authors of that famous pioneering work, "Principles of Chemical Engineering", first published in 1923. The other joint authors of the present book are former members of the Chemical Engineering Department of the Massachusetts Institute of Technology and now occupy important positions as chemical engineers in two of the greatest industrial concerns of the United States, namely, the E.I. du Pont de Nemours Company and the Eastman Kodak Company. No book intended to instil into the minds of chemistry students the fundamental underlying science and many of the essential facts and phenomena relating to the processes of many great industries could come before the public with better credentials.

As the authors explain in the preface, students starting the study of fields of applied chemistry such as the so-called heavy chemical industry possess in general an adequate background of training in inorganic, organic, analytical and physical chemistry. This is not true, however, of the great industrial field of colloidal and amorphous materials, and for two reasons. In the first place, the subject of physical chemistry is so broad that instruction to be thorough must be restricted in scope, with the result that it is not possible to deal adequately with the scientific facts and principles underlying the phenomena presented by colloid and 'amorphous' systems. In the second place, these phenomena are so complex that "many individuals prefer a purely empirical approach, but it is the conviction of the writers that it is best to submit each problem to a careful theoretical analysis, even though in the nature of the specific case this may be known to be inadequate. A major purpose, therefore, is the introduction of the student to such a method of attack".

In accordance with this admirable plan, the first 280 pages—rather more than one half of the book—are devoted to the physics and chemistry of colloids, including adsorption phenomena, large molecules, surface films, molecular orientation, and 'amorphous' solids. The treatment of these subjects is preceded by three very useful chapters dealing respectively with the structure of liquids, viscosity and surface tension. The second part of the book (pages 281–519) deals with glass, plasticization by solution (including gelatine, glue, adhesives, varnishes, lacquers and paints), paper, the plastic fibres, leather, rubber, ceramic industries, synthetic resins and plastics, and the textile fibres. This is the 'industrial' part, though—needless to say—many subjects of great industrial importance, such as wetting, spreading, detergency, emulsification, stabilization of emulsions and foams, flotation, commercial applications of adsorption, the linear polyesters, three-dimensional polymers, cellulose, starch, proteins, clay suspensions, fatty acid soaps, colloidal electrolytes, thixotropy, and the distortion of solids under stress, are discussed in the first part of the book. To complete this outline of the contents, the first part includes, besides those things already mentioned, long chapters dealing with suspensoids, amorphous solids, emulsoids, the electrochemical behaviour of colloids, gelation, emulsions and foams, and the crystalline and amorphous states. These chapters give the student an excellent account of the main facts and theories of colloid chemistry and physics, presented in a concise, lucid and accurate manner. They prepare him well for a good understanding of the industrial materials and processes which are dealt with later, though they may be read with great profit for their own sake and as a fundamental introduction to larger works and special monographs. At the end of every chapter of the book the authors give short but valuable bibliographies serving as guides to these special books and to important original papers and symposia. As every teacher and serious student knows, this is an important and valuable feature of a really good book.

The treatment is quantitative and accurate, though essentially non-mathematical. Colloid science in its present state does not require much mathematics, though when a little is required, as for example in the treatment of Brownian motion, sedimentation under gravity or centrifugal force, and electrophoresis, the authors do not hesitate to use it. The day is long gone by when the chemistry student intending to enter industry would fight shy of a differential coefficient or an integral, and nowadays he generally studies such things at school.

The chapters in the second half of the book dealing with the industrial materials and processes are so good that they may fairly be classed as unique. In the opinion of the reviewer, they constitute a new and in many respects pioneering model of how such matters should be handled. An ancient Greek philosopher, when some visitors were surprised to find him in his kitchen, is reputed to have said, "Here also are the gods". So we may say of these chapters, "Here also is science", for everywhere we find the complex materials and processes of industry set forth with such a clarity of scientific analysis that it is a joy to read about them. To quote a single example, the 50 pages dealing with rubber (natural and synthetic) can only be described as a superlative example of the fine art of science teaching, and are bound to demonstrate to the fortunate student who has access to this book that science has her home fully as much in the factory and the industrial laboratory as in the lecture rooms and laboratories of the academic campus.

It must not be thought, however, that the authors neglect the 'empirical' facts, for the matters under discussion are everywhere beautifully illustrated by diagrams, curves, tables of data, and (in certain cases) by reproductions of photographs; though the student is never weighed down by such a superabundance of illustration as would distract his mind from the correlating chain of scientific causal analysis. The authors do not write for the learned and experienced specialist. Their object, which is supremely well achieved, is so to teach the young student to apply creative thought and logical reasoning to the wealth of quantitatively ascertained and established facts that he will pass with courage and well-based hope from order to understanding and intelligent action.

Such excellence in method and presentation is no mere *tour de force*, but the ripe fruit of knowledge and experience. We can well believe the authors when they write in the preface, "This book is the outgrowth of personal practical experience which goes back over thirty years. It embodies the results of twenty-five years teaching the subject at the Massachusetts Institute of Technology. The text has been prepared entirely by members of the staff, all but one of whom have since gone into industry. Over this long period many professional associates have, through suggestions, discussion and information, made contributions of major value which are deeply appreciated."

The reviewer has little to cavil at. The following notes are mostly suggestions which the authors may perhaps consider worthy of some consideration in the preparation of the next edition:

(1) In connexion with the subject of colloidal electrolytes some more attention might be paid to soaps and to paraffin-chain salts in general (work of McBain and Hartley) and to aqueous solutions of alkali silicates (work of Harman). Hartley's little monograph on "Aqueous Solutions of Paraffin-chain Salts" (No. 367 of the *Actualités scientifiques et industrielles*, published by Hermann, Paris) might be included in the bibliography. Possibly also the Faraday Society Discussion on Colloidal Electrolytes (1934).

(2) "Suspensoids never form gels" (p. 169). Do not some suspensoids, for example, nickel (metal) and cuprous acetylide, form gels, or at least thixotropic geloids ?

(3) "Failure of osmotic methods for determination of the molecular weights of proteins" (p. 159). What about the successful work of G. S. Adair ?

(4) In connexion with the subject of thixotropy, references might be made to some of the numerous papers by Freundlich and his collaborators and also to his monograph on thixotropy (No. 267 of the *Actualités*, etc., published by Hermann, Paris).

(5) A section might be devoted to the colloidal chemistry of starch and starch pastes.

(6) Under textile fibres reference might be made to the excellent book of E. Valkó, entitled "Kolloidchemische Grundlagen der Textilveredlung" (Springer, Berlin, 1937).

(7) In the bibliography relating to suspensoids, reference might be made to the Utrecht Symposium on Hydrophobic Colloids (published by D. B. Centen, Amsterdam, 1937).

(8) Under "flotation" it would be well to refer to I. W. Wark's excellent "Principles of Flotation" (published by the Australasian Institute of Mining and Metallurgy, Melbourne, 1938).

(9) In the author index, N. K. Adam is indexed under "Adams".

(10) In the bibliography to Chapter 2, G. W. Scott Blair is referred to as "G. W. Scott". A corresponding correction is required in the author index (p. 521).

This book can be most strongly recommended to all students of chemistry (whether they intend to enter industry or not), and to their teachers as well. They will not fail to derive knowledge, satisfaction and inspiration from it. The authors are to be heartily congratulated on a fine and most valuable contribution to the advancement of science and industry.

F. G. DONNAN.

JUVENILE CRIME

Young Offenders

An Enquiry into Juvenile Delinquency. By A. M. Carr-Saunders, Hermann Mannheim, E. C. Rhodes. Pp. x+168. (Cambridge: At the University Press, 1942.) 7*s*. 6*d*. net.

BETWEEN 1928 and 1938 the number of males under sixteen found guilty in Great Britain of indictable offences approximately doubled. An increase in the number charged and found guilty does not necessarily imply an increase in the amount of crime. Nevertheless, in view of these somewhat startling figures, the Home Secretary determined to institute an investigation into the whole problem of juvenile delinquency. At a meeting convened at the Home Office early in 1938, it was decided to start with an inquiry in the London area; and its supervision was entrusted to the Director of the London School of Economics, Prof. A. M. Carr-Saunders. The procedure proposed was to collect, through the medium of the Probation Office and the Education Department of the London County Council, all available information relating to the first thousand cases brought before the juvenile courts in London after October 1, 1938. Later it was agreed to extend the inquiry to Manchester, Leeds, Sheffield, Hull, Nottingham and Cardiff. The particulars to be recorded related to such matters as the time, place and nature of the boy's offence, his attainments and conduct as assessed by the school, the number and nature of the jobs taken up after leaving school, and the characteristics of his home, his parents or guardians, and his relatives. It was also intended, after the social and scholastic conditions had been dealt with, to take up a supplementary study of the psychological aspects: this, however, was unfortunately prevented by the outbreak of the War.

The whole survey has been admirably planned; and both methods and results are described with care and lucidity. In the main the conclusions confirm those already reached in earlier investigations carried out in isolated areas on a much smaller scale. To the scientific reader the most interesting feature of the research will probably be the statistical technique adopted. In analysing the data the principle followed consists in what psychologists have called the method of 'progressive delimitation': it might be described as a form of multiple factor-analysis, starting with the factor that contributes most to the total variance, and working through other factors which are less and less important in order.

In an inquiry on this wide scale it would have been scarcely possible to obtain graded assessments. Consequently, a full correlational technique was out of the question. For the main characteristics the cases have simply been classified on a dichotomous or 'bipolar' principle with positive and negative categories. In juvenile delinquency one of the most important factors appears to be 'the structure of the family' from which the delinquent comes. Accordingly, the first step is to contrast families of 'normal structure' with 'broken' families. Then, concentrating upon the former group, the next step is to contrast those normal families in which the home 'atmosphere' is normal with those in which it is abnormal. The third step is to subdivide in much the same way the subgroup coming from homes where both the family 'structure' and the 'atmosphere' are normal. Thus, by continually selecting cases in which certain factors are relatively constant, it becomes possible to isolate in order the effects of different conditions in the child's environment.

As compared with most earlier investigations the present inquiry has two great merits: the first is the large number studied; the second, the use of a control group. As the writers point out, except for a single investigation carried out in the London area by the Council's psychologist, this latter safeguard has scarcely ever been adopted. Even in the present inquiry, practical difficulties were encountered; and the writers themselves feel somewhat doubtful how far they have been overcome. The chief weakness would seem to arise from the fact that the selection of the 'control-case' was left to the head-teacher, who was asked to name a law-abiding lad of about the same age "who could reasonably be regarded as a 'mate' to the delinquent case". It is conceivable that some of the difference ultimately found may simply reflect the head-teacher's view of what boys would be good representatives of the law-abiding majority in their own particular school.

The investigators conclude that, although the "figures are not easy to interpret, . . . it seems certain that there was some real increase in the amount of juvenile delinquency up to 1938". As regards causation they agree with earlier investigators that delinquency is due to a multiplicity of causes, and the combination of causes may differ widely from one case to another. The chief environmental factor appears to be the 'abnormal home', that is, a home in which either a normal 'structure' or a normal 'atmosphere' is lacking, where the parents are separated, or in a constant state of friction, or where the discipline is harsh or over-indulgent. A second group of conditions may be classed under the head of "opportunity for mischief": 30 per cent of the sixteen-year-old delinquents were unemployed, and one third of the offences committed during the hours of darkness. Yet these are by no means the only factors, since—particularly perhaps during periods of stress or disturbance—normal boys from normal homes may occasionally succumb to what the writers call 'stray or chance' delinquency.

Although many problems are admittedly left unsolved, the publication of this carefully conducted research, demonstrating the unquestionable influence of social and domestic factors, is particularly opportune. Of late there has been an increasing tendency, particularly among medical writers, to revive the ancient view that 'crime is essentially a form of mental illness'. The present report throws the onus of proof on those who advocate the pathological hypothesis: it now becomes incumbent on them to support their view, not merely by impressions gleaned from the study of individual cases in the clinic or the consulting-room, but also by a statistical analysis of data collected with equal care. The present investigators suggest three main lines for future inquiries: first, further statistical studies of the various environmental factors, to be carried out, not spasmodically, but continuously or at regular intervals; secondly, an intensive study of the psychological aspects with particular reference to susceptible types; thirdly, a supplementary study of the relative efficacy of different methods of treatment. Only on the basis of cumulative scientific researches can practical measures be laid down.

CYRIL BURT.

THE AIRMAN'S LABORATORY

Weather

An Introductory Meteorology for Airmen. By W. G. Kendrew. (Oxford Air Training Manuals.) Pp. 96. (London: Oxford University Press, 1942.) 2*s*. net.

THE author of these hundred pages addresses himself to the airman student who comes fresh to meteorology and has little knowledge of physics. That is not an easy task—no good elementary textbook is—and great success has not been achieved in this instance. Nevertheless, the author's aim is sound: to present a limited factual survey of the physics of the troposphere, the medium in which the student will in the main be flying, and, so that the book shall be more than an exercise of memory, to attempt some correlation of the facts themselves. No mathematics is used in the process.

Atmospheric dynamics and thermodynamics are not, within the scope of this book, essentially difficult. But they are complex, and school laboratory experience is not easily extrapolated to a large three-dimensional domain in which air does not necessarily move from a region of high pressure to one of low pressure, nor is its readiness to turn upside down determined by an increase of density with height. It is therefore due to an author, so far as present knowledge and his self-imposed limits allow, to be particularly explicit on the conditions of Nature's experiments which he is describing. One could have expected greater clarity in many instances here. Thus a clear night atmosphere is a by no means ineffective blanket in checking loss of heat from the earth (about a quarter only of the earth's radiation is allowed to escape), though a layer of low cloud is certainly a more effective blanket; the absolute humidity of air which is heated does not in general remain constant; temperature inversions are essentially of two kinds, both in mode of formation and in effect, at the surface and in the free air, and the distinction is not clearly drawn.

There are excellent concise statements on air masses, pressure systems and the synoptic weather chart, and the author has nicely stressed the importance of the actual physical qualities of the air 'on the stage' rather than the label which has been attached to it. The new student of the subject should gain a good deal from the book, but will need to read further if his ideas are to be really coherent and if he is to get the best out of the meteorological advice which as an airman he is offered.

DEFECTS OF SPEECH

Speech and Voice

Their Evolution, Pathology and Therapy. By Dr. Leopold Stein. Pp. xii+233. (London: Methuen and Co., Ltd., 1942.) 15*s*. net.

IN this elegant and well-documented study, the author uses a life-time of clinical experience and a highly developed critical faculty when discussing the cognate work of others. As befits a member of the Tavistock Clinic, the only large body of consultative and practising psycho-therapists in Great Britain, the author sees in the development of speech in the individual a parallelism to the development of the body through a compressed re-capitulation of the evolutionary development of the species through the ages. Thus, from the very first id cries of the baby every further stage of speech control, as a method of communicating ideas, is but adding a further layer of psychological development on what is more primitive. Conversely, the major defects of speech, representing loss of such higher layers, such as aphasia, dyslalia, and stammering, are treated by conducting the patient through a vocal training largely based on the evolution of language, deduced by the comparative study of primitive languages and the natural efforts of an infant in endeavouring to make his wants understood; this, of course, in addition to any *ad hoc* psychological treatment.

In the author's comparatively condensed treatment of his subject he is exceptionally clear in his definitions and meanings of the technical terms he uses; in some instances he seems to overstress derivations of words, because we know that verbal meanings tend to change as their subjects develop. But vocal *chords* is surely an archaic spelling.

Ostensibly for speech therapists, nevertheless the present text has considerable use for the general scientific reader, especially as the author deals with related phenomena, such as organic troubles, breaking of the voice, laryngectomy and speaking with the aid of air from the stomach, and vocal exercises. The main feature is the psychological approach to speech defects, and the new hope given to sufferers by modern methods of treatment.

L. E. C. HUGHES.

THEORETICAL PHYSICS IN THE U.S.S.R. DURING THE PAST TWENTY-FIVE YEARS

By PROF. DMITRY IVANENKO

THE advances of physics have been especially significant during the last quarter of a century; modern theoretical physics, in particular, is a child of this period. Our concern, in this article, is mostly quantum mechanics of recent times. The papers of 1932–38 mentioned in this article have been published in the *Physikalische Zeitschrift der Sowjetunion*, and the papers dating 1933–34 in the *Journal of Physics* (issued by the Academy of Sciences of the U.S.S.R.).

Relativity. Among the few papers on relativity theory a prominent place is due to the discovery made by the late Prof. Friedman of the non-static solution of Einstein's equations of gravitation (1922). This work has influenced the development of relativistic cosmology which has followed. We may also mention the recent memoir by Fock (1939) on the approximate solutions of the gravitational equations for bodies of finite extension, from which the equations for motion were automatically derived. Fock's calculations are much simpler than those of Einstein, Hoffman and Infeld for point masses.

General Quantum Mechanics. Mention is first of all due to Fock's approximate method, now widely used, which generalizes that of Hartree. To the same author we owe also an exhaustive treatment of quantum electrodynamics as well as a simple quantum derivation of Coulomb's law (together with Dirac and Podolsky). There is no need to dwell upon earlier studies by Fock in the relativistic generalization of Schrödinger's equations or on Frenkel's correction (Thomas-Frenkel's term) for the electron motion, as this is now discussed in text-books. It will be recalled that we owe to Frenkel the classical theory of a spinning particle (1926).

Of general interest is the idea of 'individual' error in measuring co-ordinates in the relativistic quantum mechanics. This idea, as contrasted with the common conjugate errors, was suggested by V. Ambarzumian and D. Ivanenko and developed especially by Schrödinger. 'Individual' errors for electromagnetic fields were discussed by Jordan and Fock and by L. Landau and Peierls.

Dirac's Theory. A thorough analysis of Dirac's equation has been undertaken by Ivanenko (introduction of hypercomplex numbers), by Fock (formulation by means of proper time) and others. Of particular importance is the theory of parallel displacement of Dirac's wave function (Fock and Ivanenko, 1929) by means of which Dirac's equation was immediately brought into a general relativistic form. This study was extended by Weyl, Schrödinger, Dirac and Pauli.

Meson Theory. Proca's equations were quantized by Ivanenko, Durandin and Ershov, who showed their inapplicability to electrons, but were recommended by Tukawa, Heitler and Kemmer as the best device for the description of mesons. Purely classical mesodynamics, taking account of damping, in particular, were treated by Ivanenko and Sokolov concurrently with Bhabha. The difficulties here encountered, such as the unlimited growth of cross-sections upon scattering of meson nuclei (Sokolov), the impossibility of stable orbits for a meson revolving around a nucleus (I. Tamm), etc., are all connected with the dipoleness of the meson as manifested both in electromagnetic and nuclear effects (Ivanenko and Sokolov). Hence the results of Smorodinsky and Landau (Compton effect on the meson) and those of Ivanenko, Sokolov and Rosman (population of a vacuum by meson pairs). We consider it as one of the most interesting results of the quantum theory of mesons that Sokolov (1941) has suggested a quantum account of damping which decreases the growth of cross-sections and thus eliminates a serious difficulty.

Atomic Nucleus. The modern model of the atomic nucleus composed of only heavy elementary particles suggested by Ivanenko (1943) raises the question as to new specific nuclear forces. The first model of nuclear forces realized by electrons and neutrinos was developed by Tamm and Ivanenko (1934). This is still a specimen for every model of forces (compare, for example, the prediction of non-central forces by Tamm, although as shown later on by Tukawa the principal part is played here by meson forces).

The statistical theory of the nucleus was extended by Frenkel (nuclear temperature, electrocapillary vibrations, spectroscopy and fission) and by Landau (distribution of energy-levels). A detailed analysis of the chain reaction of the fission of uranium was carried out by Khariton and Seldovich. Migdal has analysed the tracks of the fission products.

Cosmic Rays. The complex equations of the shower theory of Heitler and Bhabha and of Oppenheimer and Carlson were first integrated in a concise form by Ivanenko and Sokolov (1938) with the aid of Mellin's transformations already mentioned in a previous publication by Landau. Further refinement was brought about by Tamm and Belenky, taking due account of the ionization losses.

Statistics and General Theory of Solids and Fluids. The general statistical theory of a continuum was given by Leontovich, Mandelstamm, Leontovich; and their associates (Shaposhnikov, Vladimirsky, Galanin) have treated by classical means the study of various cases of sound absorption in fluids, strong and weak electrolytes, emulsions and suspensions. Much work was done on solids by Frenkel, who has just completed a monograph on fluids. Suffice it to mention his studies of excitation waves and some recent studies in plasticity (in collaboration with Kontorova, 1940), on the temperature dependence of surface tension (1940), and on the mechanical properties of amorphous bodies. We owe to Tamm an interesting consideration of the surface-levels of electrons in crystals. Landau has developed a very general fundamental theory of phase transitions 'of the second kind' connected with a jump in symmetry (1937). This study was extended by E. Lifshiz (1941).

Landau and his associates, Akhieser and Pomeranchuk, treated sound absorption in solids by means of quantum mechanics. According to the recent hypothesis advanced by Landau, superfluid helium II is considered to be in a state of potential quantized motion which lies lower than the state of vortex motion.

Quantum Theory of Metals and Semi-Conductors. In this connexion we may mention, first of all, the pioneer work, at Joffe's Physico-Technical Institute, of Frenkel on electronic and 'hole' conductivity, on rectification, etc. It will be noted that Frenkel was the first to suggest the ingenious idea of the degenerate gas in stars. Some valuable work on semi-conductors has been done by Blokhinzev and Davydov.

An interesting result of Landau's work is the proof of diamagnetism of the quantum electron gas. It was shown by Landau that in a transient state superconductors are composed of alternating common and superconducting regions.

As to the quantum theory of metals, Tamm and Blokhinzev have ascertained the role of image forces in the escape of electrons, and Tamm has discussed in detail the photo-effect from metals.

Many properties of ferromagnetic bodies have been accounted for by I. Akulov's anisotropy law. The quantum theory of ferromagnetic alloys, magnetostriction, etc., was developed by Vonsovsky (1940). The role of anharmonic effects in conductivity was discussed by A. Smirnov. A noteworthy place is occupied by Granovsky's and Vlasova's work on plasma.

Optics. Numerous detailed computations of spectra were carried out in the Leningrad Optical Institute by means of Fock's approximate methods. Much work was done on molecular spectra by Eliashevich and Stepanov. The modern theory of phosphorescence as a series of bimolecular reactions was developed by Blokhinzev (1937). Mandelstam and Leontovich extended the classical, and Tamm the quantum, theory of the Raman effect in solids. Leontovich studied the Rayleigh scattering in anisotropic fluids.

Among the ideas of Mandelstam's school mention may be made of an ingenious explanation by Tamm and Frank of the new kind of radiation, discovered by Cherenkov in Vavilov's laboratory, as due to electrons moving at a velocity exceeding the phase velocity of light in the given medium.

It is not possible to discuss, within the confines of the present article, various problems of classical electrodynamics and their technical application as pursued by Mandelstam and Papalexi with their associates Rytov, Filipov and others. Mention may, however, be made of the theory of non-linear vibrations, which has had some interesting practical implications (compare the monograph by Andrianov and Khaikin).

The above is a concise outline of the development of theoretical physics in the U.S.S.R. We may point with satisfaction to the existence of several scientific schools, and of a great number of young men of science who have already done valuable research. Work on theoretical physics carried out in the U.S.S.R. during the past twenty to twenty-five years has played a noteworthy part in modern developments of the subject.

TERMINOLOGY IN THE GEOLOGICAL SCIENCES

By Dr. R. H. RASTALL

FOR many years past and especially of late in publications and conferences dealing with war-time problems and post-war planning, much stress has been laid on the unfortunate fact that in Great Britain the governing classes and the general public are not geologically minded. This is not the place to discuss in detail the disastrous neglect of economic and applied geology and mineralogy in some of the universities of Great Britain, but it is proposed rather to point out some ways in which the study and appreciation of geology by ordinary non-specialist educated people is rendered unnecessarily difficult.

One of the most glaring of these obstacles is by no means confined to geology, but is common to all biological sciences, namely, the volume and complication of the nomenclature now current. To the ordinary person, these sciences present themselves mainly as masses of outlandish and arbitrary names, which seem to have no sense or reason about them. Now there can be no doubt that of late years this has got much worse in geological studies, owing to the superabundance of minute detail now prevailing both in stratigraphy and palæontology. Fortunately, in petrology there has recently been a definite reaction against the multiplication of unnecessary names, although even this has not received all the support that might be wished.

By far the greater part of the trouble arises from the activities of the palæontologists. It is now a common saying and only too true that a field worker cannot name his own fossils: they all have to be sent to a specialist—a most unfortunate state of affairs, and a very unfair handicap on the field-worker. It remains to consider what are the real causes of this situation. First of all, there is one inevitable reason: the extension of knowledge, against which nothing can be said. But the real crux is the way in which that extension of knowledge is employed. Now, unfortunately, the whole tendency has been and is to make things infinitely more complicated, instead of any attempt at simplification. It is commonly understood that modern palæontology is supposed to be founded on evolutionary lines, but it really seems that the present tendency to hair-splitting distinctions and infinite multiplication of new names is exactly contrary to the true principle of evolution. All the emphasis is on differences instead of resemblances: dividing instead of grouping. Many such distinctions correspond to extremely minute differences. Hence natural relationships are concealed, not emphasized. This is not the spirit of Darwin and Wallace.

In palæontology this tendency finds expression in the institution of new genera. In the case of new and hitherto undescribed fossils this is, of course, necessary, but the reference is here to the infinite sub-division of old and well-established genera. It is scarcely too much to say that almost no fossils known in the times of William Smith, Lyell, Buckland, Sedgwick and Murchison still retain the same names, and it might almost be said of the era of Lapworth and Geikie. Such well-known names as Terebratula, Rhynchonella, Ostrea and Pecten have practically disappeared from the literature. The graptolites have probably suffered less than any other group in this way, probably because the authorities on this group happen to have been outdoor geologists. One such alteration in this group may perhaps be mentioned: the abandonment of the earlier name of Nemagraptus, which led too obviously to undergraduate attempts at humour (but I see no graptus).

The last sentence but one really touches the root of the matter. All these modern developments are mainly due to museum specialists; people with the Civil Service mind, who spend all their time indoors, surrounded by mountains of monographs instead of mountains of rocks, and appear to delight in making everything as complicated as possible. This is not evolutionary progress, but obscurantism, and if natural science in any form is ever to become a serious part of general education it will have to be amended.

Another factor, admittedly of less importance but still real, is the strict and indiscriminate application of the laws of priority, whereby old and universally known names are displaced by others discovered by antiquarian grubbing in forgotten publications. The motto here should be "let sleeping dogs lie", or "quieta non movere".

One result of all this is that an ordinary geologist who learnt his elementary work, say, forty or fifty years ago, when reading a modern stratigraphical paper often has a very vague idea of what it is all about, unless he happens to be a specialist in that particular subject. Sometimes the specific name may give him a clue to the identity of a fossil assigned to some genus of which he has never heard. Otherwise he may vainly hunt through much literature for an explanation.

This leads on naturally to another important side of the subject, namely, the effect of all this on the general view of geology taken by less specialized and especially by amateur readers; what may well be called the popular view. This can be simply summed up in a single phrase. *Popular geology is being killed by pedantry,* and even in schools and universities the subject is rendered so unattractive that few students select it. The falling off in the number of students of geology in many universities is notorious, but the special point to be made here is that this falling off is not the fault of the teachers, but of the state to which the science itself has been reduced by people who are not teachers, and moreover are not sufficiently men of the world to realize the disastrous effect on the science and its practical applications in the future of their well-meaning but wholly misdirected efforts.

Another instance may be mentioned as affecting what used to be a favourite field for amateurs, namely, the incessant introduction of new and uncouth names for minute sub-divisions of prehistoric cultures. This is usually considered to be part of geology, but it is really prehistoric archæology, and modern developments have made it quite unsuitable for inclusion in elementary teaching courses, owing to the multiplicity of detail. Students who take geology for any purpose beyond the mere attainment of a degree cannot afford to spend the necessary time on this kind of thing.

It is often said in academic circles that the study of parts of a scientific subject having no practical applications is an excellent preparation for something else later on; this sounds remarkably like the usual argument for a classical education. It is, of course, true that specialization can and often does begin too soon, but surely elementary education should be wide, not deep.

Another deterrent to the popularization of geology, so obvious as to make detailed discussion unnecessary, is the enormous number of zones and sub-zones now recognized in several systems; as, for example, the ammonites in the Jurassic and the graptolites in the Silurian. Furthermore, the names now applied to the ammonites in particular can only be described as appalling and quite sufficient in themselves to choke off any nascent interest in the subject, either in students or amateurs.

Finally, reference may be made to a complication for which there is an easy remedy. That is the practice of invariably quoting after the name of a fossil the authority by whom it was first described, even in supposedly popular or semi-popular writings. It is, of course, obvious that this must often be done in technical discussions by specialists, but it is submitted that it is entirely out of place in texts intended for students or amateurs. The effect on students is most depressing. They conclude that they are expected to learn three words for the name of every fossil, and also to remember the meaning of the abbreviation which often represents the name of the authority. Then there is the further complication of the brackets in which the name of the authority is often enclosed, which means that the said authority did not call the fossil by the name there printed, but something quite different. Incidentally, owing to a reason before discussed, nearly all names now have these brackets. The effect on amateurs is equally depressing.

Fortunately, petrology and mineralogy get on very well without such a system, although in point of fact in petrology there would probably be more excuse for it, since many rock-names have been used in varying senses; for example, the very common name *dolerite*. But it may well be considered what petrological literature would be like if one was compelled to write "basalt Pliny" or "granite God knows who" every time. For mineralogy the imagination reels at the prospect. Cannot palæontologists be induced to compare their own proceedings with this?

The state of affairs here sketched must obviously be a passing phase, and there should eventually be found some means of simplification. If not, as a result of forty years experience of geology in all its branches, especially in teaching, it can only be said that the prospect is dark indeed.

FREEDOM IN SCIENCE

By Dr. H. LOWERY

War-time necessity has required that science shall be planned in its applications to the problems of national defence, food production, and other matters connected therewith. Indeed, the success or failure of a nation at war is easily seen to depend mainly upon how well it is able to utilize its scientific knowledge.

We must be careful, however, to distinguish between science on one hand and the applications of science on the other, a distinction that may be represented by the difference between science and technology. Science is concerned with the disinterested and dispassionate search for truth, and the man of science at work cannot see whither the road he travels will lead him. He must on occasion be prepared to follow what looks like a by-path, and it is vitally important that he should be free to do so if he chooses to leave his main road. A characteristic feature of technology, however, is that it is concerned with more or less clearly defined ends; the technologist sets out to achieve a definite object, improving a manufacturing process, carrying out to its logical conclusion some practical possibilities inherent in some general scientific principle, as, for example, when he sets out to design an electric motor for a particular purpose. While it is true that the technologist in his endeavour to achieve his goal may discover interesting new facts and may actually follow up some of these, nevertheless as a technologist he must carry out his original intention if he is to be successful at his job. Many of the larger research associations are sufficiently enlightened to recognize that their technologists may come across new possibilities, and are prepared to give their research workers their head, as a result of which countless advances in knowledge have been made in industrial laboratories, especially in the United States, which cannot be described other than as 'pure science'. On the other hand, not a little work of a distinctly technological nature has emerged from the universities.

No one will deny that technology is important in our life. Not even the most ardent scientific man would want to ban the practical achievements of the technologist. Unfortunately, the uncontrolled applications of the objective sciences as against the almost complete neglect of the applications of the social sciences have brought us perilously near the abyss of collapse of our civilization. As a result, there is a widespread belief, resting on a fallacy, that a complete planning of scientific investigation from above, presumably by the State, is the only way to our material salvation. The fallacy lies in the fact that scientific research as distinct from technological research cannot be planned. The man of science cannot see the end of his investigations and must be content to have faith and follow where truth leads ; the man of science, unlike the technologist, cannot be judged by results, he cannot work to a time-table. His greatest moments of inspiration and insight may, and often do, occur when to the onlooker he is 'off duty'. Many of his most brilliant successes are the result of chance occurrences and of his freedom to take advantage of accidental happenings and observations, with the consequent need for change of direction in his work —a diversion which under rigid planning from above would not be permitted.

There is one important implication in planning which is often overlooked by planners, and that is that the more life is planned the less freedom there is for the individual, a fact which has recently been stressed by the Archbishop of Canterbury. If science were completely planned, the research worker would no longer be independent or able to choose his own line of investigation. He would have to work continuously according to some hypothetical formula or even political slogan, always being prepared to subordinate his intuitions, his conscience and his intellect to the dictates of the superimposed policy. We cannot contemplate any scientific man, not to speak of a Faraday, a Newton or a Maxwell, doing creative work under these conditions.

In a recent lecture to the London and Home Counties' Branch of the Institute of Physics, Dr. J. R. Baker, of the Department of Zoology of the University of Oxford, gave a stimulating account of the *desiderata* in the conditions under which the man of science should work, emphasizing in particular the importance of free choice in following up any new suggestion or chance occurrence in his investigations. Dr. Baker did not deny that the prime service of the man of science is to make his maximum contribution to the community through his own particular sphere of activity, which is akin to that of the artist and the musician. Without saying so explicitly, he did nevertheless suggest that the man of science working in the realm of ideas is akin to the student of æsthetics, a field in which the mere notion of planning is ludicrous. The guiding principle behind Dr. Baker's remarks was simply that planning of the work of the man of science will defeat its own ends through strangulation of the very spirit of science. He made it quite clear that he did not see any opposition between science and technology.

Indeed, in the subsequent discussion on Dr. Baker's lecture, it was easily seen that the technologists were in broad agreement with him on the need for freedom of the scientific worker. It was clear, however, that science is being attacked from within. Certain men of science, apparently misled by the undoubted need for the close linking of the objective sciences and the social sciences, have quite wrongly come to the conclusion that this link should take the form of *complete* planning of all science. Other motives, possibly of a purely political nature, seem also to be involved. It must not be forgotten, however, that the scientist, as a scientist, is not concerned with politics or even with applications, and therefore controls of any kind and the emotional associations which are invariably aroused by political action are inimical to his scientific advance.

During the vigorous and lengthy discussion which followed Dr. Baker's lecture, many aspects of scientific work were raised, a few only of which can be chosen for mention here. One speaker pointed out that in any country only a small number of people will either have the ability or resources to spend their lifetime in purely scientific research. Most prospective men of science are hampered by the need to make a living. They must therefore work in conjunction with research associations and other organizations which are primarily concerned with technological applications. It was pointed out, however, that even in associations of this kind, there is room for the scientifically inclined investigator to fulfil his hopes and ambitions and so follow up chance discoveries without concern as to any material end.

In this part of the discussion some members of the audience were worried as to the distinction between pure science and applied science. Rigorous definitions are impossible, but Dr. Baker suggested as the chief distinguishing characteristic the fact that scientific results are of permanent value, whereas technological results are of ephemeral value, being out-dated by further technological achievements in the same field —he quoted, for example, the out-dating of the musical box on the advent of the gramophone.

Another speaker referred to the ample resources for scientific research provided in the U.S.S.R. and emphasized that scientific work must have due relation to the needs of the country. Another point made was that the task of the man of science is to lead the people, and therefore he cannot remain aloof from political and social questions.

A scientific worker who had had experience both in industry and in university research emphasized that no gap really exists between pure and applied science, but pointed out that, on the whole, British industry has in general failed to realize how best to utilize the services of the scientific man. It has expected final results too soon and has not been bold enough to pin its faith on the activities of the scientifically trained man. He pleaded for a more adventurous spirit in the attitude of British industry towards science, and hoped that industry would give greater support to scientific research after the War than it has done in the past, as there can be no doubt that the development of new industries and the building up of a virile export trade cannot be accomplished without using to the full the contributions that men of science can make to the community.

Throughout the discussion reference was frequently made to the need for the precise definition of terms, particularly the term 'truth' in the expression that 'science is concerned with the search for truth'. As one speaker aptly expressed the problem in reference to X-rays: Which is to be regarded as truth, (*a*) the fact that we can measure the wave-length of X-rays, or (*b*) the fact that we can use X-rays for therapeutic purposes? Again in regard to chloroform, (*a*) we know the chemical structure of the substance, and (*b*) we can employ it in order to alleviate pain. In each case are not the two aspects of our knowledge intimately bound together? This speaker concluded that we are unable to insist on the freedom of pure science.

From what has been said above, it will be clear that Dr. Baker opened up an important subject for consideration in war-time when everyone is deeply concerned with what we are to do with our lives both as individuals and as members of the community. His problems are of more than mere academical interest, and an outside observer at the discussion could not fail to be impressed with the sincere desire of the many scientific workers present to make their due contribution, in whatever form may be most appropriate, to the best needs of the community.

THE MALACOLOGICAL SOCIETY OF LONDON, 1893-1943

On February 27, 1893, W. H. Hudleston, F.R.S., then president of the Geological Society, presided over a meeting at which the Malacological Society of London was inaugurated and the first council elected with Dr. Henry Woodward, F.R.S., as first president. On February 27 last the Society commemorated its jubilee in the rooms of the Linnean Society at its 415th meeting, with the twentieth president, Dr. A. T. Hopwood, in the chair.

Of the original seventy members Mr. E. R. Sykes (president 1904–7) and Mr. J. R. le B. Tomlin (president 1916–19) sent greetings, and Mr. A. S. Kennard (president 1922–25) gave an account of the Society's early history. Founded for the study of Mollusca, it owed much of its success to the enthusiasm of its first secretary, E. R. Sykes, and to the assistance of E. A. Smith, who was in charge of the British Museum Mollusca from 1871 until 1913. The Society early attracted notice in other countries and among the fifty-one corresponding members of its first year were included: W. H. Dall (1845–1927), who studied under Agassiz; C. Hedley (1862–1926), R. Tate (1840–1901), Joseph C. Verco (1851–1933), in Australia; F. W. Hutton (1836–1905), H. Suter (1841–1918) in New Zealand; H. C. Burnup (1852–1928), of the Natal Museum; Ph. Dautzenberg (1849–1935), of Paris, and the Marchese di Monterosato (1841–1927), of Palermo, two of the greatest private collectors; P. Fischer (1835–1893), best known of that family of many malacologists; M. Cossmann (1850–1924), who despite the heavy duties of chief technical officer of the Chemin de fer du Nord wrote a revision of the Paris Basin mollusca; A. Brot (1821–1896), of Geneva; S. Brusina (1845–1898), of Agram University; W. Kobelt (1840–1916); E. von Martens (1831–1904), first, and for twenty-one years, recorder of the molluscan section of the *Zoological Record*. The keen interest of H. A. Pilsbry, elected in 1894, brought in more American members, including C. W. Johnson (1863–1932), co-editor with him of the *Nautilus*. The cosmopolitan interest of the Society is marked by the fact that from 1908 until 1939 the number of corresponding members exceeded that of ordinary members. Nevertheless, the pulse of the Society has always centred in the meetings in London, which have mostly been held in the Linnean Society's rooms, though for a year (1928–29) the Society met in University College, and since 1939 many meetings have been held in the British Museum (Natural History).

The Society has always had good service from its officers, some of whom have served for long periods: J. H. Ponsonby was treasurer from 1900 until 1916; the present treasurer, Dr. R. L. Cox, was elected in 1926 and since 1939 has also served as acting secretary *vice* Captain G. I. Crawford, absent on war service; A. E. Salisbury (president 1933–36) served as secretary from 1919 until 1933; B. B. Woodward (president 1907–10) and E. A. Smith (president 1901–04) between them edited the *Proceedings* from 1893 until 1925, the former for periods of eleven and nine years and the latter for twelve years.

One object in founding the Society was to bring palæontologists into touch with workers on recent Mollusca. A similar motive brought into being the Société malacologique de Belgique, the *Annales* of which contain far more fossil than recent work. Fossil Mollusca figure largely in the Society's *Proceedings*; one may instance the many papers by R. Bullen Newton (president 1910–13) and by G. C. Crick on cephalopods, notably two on the pro-ostracum and arms of belemnites[1]. More recently, a series of papers from 1925 onwards by A. Wrigley on English Eocene and Oligocene gastropods illustrates the value of co-ordinating recent and fossil studies, while Dr. L. R. Cox has contributed many papers on Tertiary and Mesozoic shells, notably a study of the rudist genus Trechmanella[2]. Much of the work on British Pliocene and post-Pliocene non-marine Mollusca by A. S. Kennard and B. B. Woodward appeared in vols. 2–24 of the *Proceedings*. The close though informal association of the Society with the British Museum indicated by the above names was remarked upon by Dr. A. T. Hopwood in his presidential address to the jubilee meeting, and emphasized by Dr. C. Forster-Cooper in his reply.

Mr. R. Winckworth (president 1939–42) exhibited the *Malacological and Conchological Magazine*, produced by G. B. Sowerby in 1838 and 1839 with the object of inducing "noblemen and gentlemen" to found a society: he also gave some statistics of the *Proceedings of the Malacological Society*, now in its twenty-fifth volume and totalling 8,054 pages.

Anatomy very properly holds an important place in the *Proceedings*. The first paper read and published was on the anatomy of Paryphanta by H. H. Godwin-Austen (president 1897–99), who contributed so largely to our knowledge of Indian land Mollusca. M. F. Woodward, son of H. Woodward, had already written some important anatomical papers before his death in an accident at Ballynakill at the age of thirty-six: his most important work, that on Pleurotomaria, was published elsewhere[3]. S. Pace, R. H. Burne, H. A. Pilsbry, H. Watson, N. H. Odhner, H. H. Bloomer and many others have added to this subject in the *Proceedings*, the last important paper being one by K. M. White on the pericardium and pericardial gland in lamellibranchs[4]. The radula has naturally received much attention, especially from A. H. Cooke (president 1913–16) and A. J. Peile (president 1925–27). Molluscan fæces, a subject initiated by H. B. Moore, which yielded valuable results in systematics as well as in the study of submarine deposits, form the subject of a survey by him twelve years ago[5].

Many pages naturally are devoted to the description of new forms, such as the papers on British Museum material by E. A. Smith and the long series of papers by J. C. Melvill (president 1929) on shells from the Persian Gulf and Gulf of Oman dredged during 1890–1914 by Captain F. W. Townsend, who contributed his own reminiscences on collecting[6].

On the British non-marine Mollusca there are at least three important systematic monographs, that of A. S. Kennard, A. E. Salisbury and B. B. Woodward on Unionidæ[7], of H. E. Quick on Succinea[8] and A. E. Ellis on Pisidium[9]. A. E. Boycott, the most revered of presidents (1927–29), and that great naturalist, C. Oldham, have given papers on ecology and genetics. Boycott's great work on the inheritance of sinistrality in Limnæa involving a million individuals was published by the Royal Society[10]; a subsidiary investigation on abnormal forms[11] figures *inter alia* a snail so equally poised between dextral and sinistral that its shell was a simple cone.

The size of the *Proceedings* does not often permit long papers. There are, however, some catalogues for which the Society has waived its usual practice, that of Columbellidæ[12] by S. Pace, of Marginellidæ[13] and of Conus[14], both by J. R. le B. Tomlin, and the revision of British nudibranchs by T. Iredale and C. H. O'Donoghue[15]. Much of F. A. Schilder's work on cowries was published by the Society, including the prodrome of a monograph of the Cypræidæ[16], "perhaps the first attempt to apply on a large scale to marine animals . . . methods of geographical delimitation of races"[17].

C. D. Sherborn's work on the "Index Animalium" directed the attention of naturalists to the importance of the bibliography of natural history. From 1901 onwards many bibliographical papers appear, the last being one by A. S. Kennard on the *Histoire* and *Prodrome* of Férussac[18]. The subject now has its own society and journal.

Exhibits have always been an interesting feature at the meetings and their records are often of interest; for example, W. G. Ridewood's exhibit of Phœnicurus[19], a genus which proves to be based on the cerata of a nudibranch. A year after Röntgen's discovery in 1895 of X-rays, a series of 'skiagraphs' of shells and living molluscs was exhibited[20]; the published plate of a nautilus must be counted an incunabulum of X-ray photography. Recently X-rays have been used to confirm the systematic relations of the rare shell Thatcheria[21].

At the jubilee meeting Prof. C. M. Yonge surveyed fifty years' work on functional anatomy, referring especially to the study of the molluscan gill, ciliary feeding, musculature, innervation.

Mr. A. Blok gave an account of shells and ornament, accompanied by a big range of exhibits from savage ornaments to modern industry, touching on ethnological and artistic aspects. Art at its lowest was seen in some of the Victorian 'horrors' and 'rubbish for tourists', while the highest level was shown in some of the cameos exhibited: the best known cameo artist was Benedetto Pistrucci, who also designed the George and dragon of our gold mintage.

Dr. L. R. Cox concluded the jubilee addresses with a review of fifty years of molluscan palæontology.

Honorary membership was instituted in 1921 when Dr. Woodward, the first president, Dr. Paul Pelsenier and Dr. C. D. Sherborn were elected. Since then, apart from previous members of the Society, J. W. Taylor, founder of the *Journal of Conchology* and of the Conchological Society, Prof. D. M. S. Watson and Sir D'Arcy Thompson have been added. Dr. H. A. Pilsbry, who recently celebrated his eightieth birthday, was elected an honorary member at the jubilee meeting.

In 1926 Mr. H. McClelland generously presented every member of the Society with a general index to the fifteen volumes of *Proceedings* and sixteen volumes of the *Journal of Conchology*, which he had prepared and published. The history of the Conchological Society has been recorded by Dr. J. W. Jackson[22]. Percy Edward Radley (1861–1927), a keen amateur of conchology and microscopy, bequeathed his library to the Society. This is kept in the library of University College, London.

In France, malacology has been represented chiefly by the *Journal de Conchyliologie*, founded by S. Petit de la Saussaye in 1850 and since 1860 associated with the Fischer family. In 1935 the direction of the *Journal* organized a *Réunion amicale* of conchologists, malacologists and palæontologists, at which Mr. A. Blok represented the Society. It was resolved to hold triennial meetings in Paris, Brussels and London, but subsequent events have prevented the fulfilment of this plan, which it is hoped will be revived after the War.

[1] *Proc. Malac. Soc.*, **2**, 117 (1896) and **7**, 269 (1907).
[2] *Proc. Malac. Soc.*, **21**, 42 (1934).
[3] *Quar. J. Micro. Sci.*, **44**, 215 (1901).
[4] Reviewed in NATURE, **150**, 771 (1942).
[5] *Proc. Malac. Soc.*, **19**, 281 (1931).
[6] *Proc. Malac. Soc.*, **18**, 118 (1928).
[7] *Proc. Malac. Soc.*, **16**, 267 (1925) and **17**, 191 (1927).
[8] *Proc. Malac. Soc.*, **20**, 295 (1933) and **21**, 96 (1934).
[9] *Proc. Malac. Soc.*, **24**, 44 (1940).
[10] Boycott, Diver, Garstang, Hardy and Turner, *Phil. Trans.*, B, **219**, 51 (1930).
[11] *Proc. Malac. Soc.*, **19**, 141 (1930).
[12] *Proc. Malac. Soc.*, **5**, 36 (1902).
[13] *Proc. Malac. Soc.*, **12**, 242 (1917) and **13**, 41 (1918).
[14] *Proc. Malac. Soc.*, **22**, 205 (1937).
[15] *Proc. Malac. Soc.*, **15**, 195 (1923).
[16] *Proc. Malac. Soc.*, **23**, 119 (1938–39).
[17] NATURE, **144**, 642 (1939).
[18] *Proc. Malac. Soc.*, **25**, 12 and 105 (1942).
[19] *Proc. Malac. Soc.*, **8**, 121 (1908).
[20] *Proc. Malac. Soc.*, **2**, pl. 15, 179, 205 (1897).
[21] Eales, *Proc. Malac. Soc.*, **23**, 15 (1938).
[22] *J. Conchol.*, **18**, 65 (1927).

OBITUARIES

Dr. Leopold Frommer

DR. LEOPOLD FROMMER, of High Duty Alloys, Ltd., died after an operation on January 27, at the age of fifty. He was born of Polish parents and obtained his diploma in mechanical engineering at the Technical University of Berlin (Charlottenburg).

I first met Dr. Frommer in 1929, when he was working under Prof. M. Polanyi at the Kaiser Wilhelm Institut für Physikalische- und Elektrochemie, in Dahlem, Berlin. He had just given up what promised to be a very successful industrial engineering career in order to take up fundamental research on the study of chemical kinetics. My interest was aroused, however, by his great knowledge of the pressure die-casting technique and his ability to apply fundamental engineering and physical principles to this highly commercialized process. For some time I had been thinking out ways of applying the pure scientist to technical problems, and in Frommer I found a man who in himself bridged the gap between the two, being that rare combination of a really practical engineer and a very competent scientific man.

In 1934, when Dr. Frommer was forced to give up his work at the Kaiser Wilhelm Institut, he came to England. Having completed his well-known book, "Handbuch der Spritzgusstechnik", he no longer retained any great interest in die-casting and was bent on a career of scientific research. Some time before, I had instituted in the High Duty Alloys research laboratories an investigation by means of X-ray crystallography into the determination of internal stresses in light-alloy components, the long-range objective of which was to enable us to control the manufacturing conditions which were responsible for these stresses. I offered to put Dr. Frommer in charge of this work and he readily accepted, seeing that this was a research problem after his own heart. He got down to work on the development of new experimental methods with extraordinary enthusiasm, and shortly afterwards undertook the additional tasks of developing spectrographic and colorimetric methods for routine analysis.

Dr. Frommer quickly organized the necessary departments in the laboratories and in two years had handed over spectrographic and colorimetric analysis for routine testing purposes. His main interest and greatest achievement were still, however, in the work on X-ray crystallography. He solved the problem of applying the technique to the measurement of internal stresses in aluminium and magnesium alloys, and designed some remarkable pieces of apparatus for applying these measurements to the largest aircraft components. The results he achieved were of real practical value and gave us much clearer insight into the formation of these stresses. Some of his work has been published and a great deal more will be published as soon as arrangements are complete. I believe that when all his results are known, he will be acknowledged to have added greatly to our knowledge of physical metallurgy.

In 1939 he was given the task of applying the technique of the measurement of internal friction of metals to technical problems, and here again found a research item which gave full rein to his peculiar talents. At the time of his death, he had evolved a technique incorporating many novel features for carrying out these measurements.

Dr. Frommer was a prodigious worker who never spared himself even when in ill-health. He was a most resourceful experimenter who brought a sound knowledge of mechanical engineering to aid him in his fundamental studies. He had an extraordinary capacity for rapidly assimilating and applying all the published information on any new problem which confronted him. His impatient and relentless pursuit of complete mastery of the many problems encountered in his researches made him grudge the time taken in writing reports, and in spite of repeated urging, the preparation of his results for publication lagged far behind his actual accomplishments and so, tragically enough, he was not spared to present many of his own most important discoveries. Thanks, however, to his admirable organizing abilities and planning, the departments which he built up will be able to carry on smoothly with the work which he initiated.

His untimely end at the early age of fifty is a great loss, both to pure physical science and to industrial research, and his many scientific friends and colleagues will feel a deep sense of loss at the passing of this able man, who at once possessed the highest qualities as a scientific worker and as an engineer.

W. C. Devereux.

NEWS and VIEWS

University of Birmingham

In his report to the Council, presented to the annual meeting of the Court of Governors, the Vice-Chancellor, Dr. Raymond Priestley, spoke of the future of the universities. "University education properly directed could be a mighty means towards the salvation of mankind. University education as it is to-day must accept its share of responsibility for our present plight." The most urgent need of the University of Birmingham is funds to effect the transfer of the Faculties of Arts, Law and Education, the University Library and central administrative offices, from the city to Edgbaston. Then three more hostels are required for the men and one for the women, and a headquarters for the extra-mural department which deals with adult education. This much is necessary to accommodate post-war students, a large proportion of whom will be men and women who have been taught, in the school of war, to know what they want and to see that they get it. The University should be ready to help in training the experts and the teachers of the devastated lands. The Council has already promised to take without fee a number of Chinese students.

Dr. Priestley spoke of some innovations which have been made. When the University decided to make physical training compulsory for all first-year students, it was intended to appoint a whole-time University medical officer whose business was to be the routine examination of all men students (most of the women were already examined on entry) and to keep a constant watch on the physical education programme. The demand of the Services for medical men, however, made it impossible to carry out the plan as originally intended; but the post has been filled on a temporary basis by the appointment of a member of the clinical staff (Dr. G. A. Auden). Another innovation was the establishment by the Faculty of Arts of special courses in modern studies, in view of the reorganizations which are bound to follow the end of hostilities. These courses deal with modern history, geography and modern political theory, and require the study of a foreign language. They are combined with a 'conference' consisting of lectures on present-day world-affairs, followed by short discussions. In the Department of Zoology, Prof. Lancelot Hogben has organized a course of lectures on social biology (open to all the University), which is intended to give some knowledge of the biology of man, of nutritional, housing, and sanitary standards, vital statistics, human heredity and educability, and of the biology of useful and destructive animals and plants. The course has been well attended.

Discoveries at Velikie Bolgary

THE site of Bolgary on the Volga just below the confluence with the Kama has been known since the eighteenth century. It is interesting as the most northerly outpost of Islam. It is marked by ruins of mosques, baths and other public buildings characteristic of a Moslem town, and on its site have been found tiles, fragments of fresco, mirrors and coins. The inhabitants were Turks of a sort; another branch of them settled in the Balkans and founded the Bulgar State. On the Volga the Chuvash are their descendants. Their State is mentioned by all the Musulman geographers. After some prosperity lasting from the tenth to the thirteenth century, it was destroyed by the Mongols, but the city lingered on for another century. Its place has been taken by Kazan. Prof. Alexey Smirnov reports that from 1938 until the outbreak of the war with Germany he has been excavating the site, the White and Black Halls (baths), a minaret, mausolea, a large paved square and remains of wooden houses and grain pits. The baths show the traditional perfection of the eastern bath. The finds are being carefully preserved for the Autonomous Tartar Republic.

Portuguese Anthropological Studies

PROF. A. A. MENDES CORRÊA has published, from the Institute of Anthropology of the Faculty of Sciences of the University of Oporto, under the title "Da Raça el do Esperito", a volume of essays on various anthropological subjects ranging from crime from an anthropological point of view to the Japanese in Brazil; from a study of the Portuguese people to race and moral values. Prof. Mendes Corrêa is well known as an anthropologist and many of his ideas will be found interesting. It is perhaps a pity that he has chosen to write in a language which cannot be said to be universally known. The same author recently read a paper before the sixteenth congress of the Spanish Association for the Advancement of Science, which was held at Zaragoza in 1940. His subject was "Perspectivas duma anthropologia citológica". Once again, however, the language difficulty supervenes. This could perhaps have been overcome by the addition of short summaries in French or English.

Coloured Arc in the Sky

MISS F. E. PENROSE states that on February 8, between 4 and 4.15 p.m. B.S.T., she saw from the East Cliff, Bournemouth, "a portion of a 'bow' resembling a rainbow almost overhead. About a fifth of the arc—the southern portion only—could be seen against a blue sky mottled with white cloud. Had the arc been complete, it would have formed a ring very slightly south of the zenith. It was not raining at the time".

There can be little doubt that this was the rather rare 'arc of contact' to the halo of 46°, described by Dr. F. J. W. Whipple in the "Dictionary of Applied Physics", vol. 3, p. 532, for although no such halo is mentioned, the halo, if visible at all, is apt to be faint, and the coloured arc at its best is a magnificent display of the colours of the spectrum. The Bournemouth description is in general agreement with a similar appearance seen near Stroud (Glos.) in the early afternoon of January 26, except that near Stroud both the 22° and 46° haloes were present, together with part of the mock sun ring and two mock suns, while the arc seemed to the present writer to be centred on the zenith. A similar coloured arc was seen in Wiltshire on January 21. This arc is apt to be too high in the sky to attract notice in normal times, and may seem to be getting more common merely because so many people now systematically examine all parts of the sky that an appearance of this kind can scarcely be overlooked.

Eradication of Wild Onion

WILD onion is a troublesome weed on heavy land in many English counties as well as in vast areas of the United States and Central Europe. It poses a serious problem to the farmer as it has the property of tainting milk and wheat, and once established is extremely difficult to eradicate from either pasture or arable land. Hitherto only partial success has attended measures for its control, but Mr. J. R. Tinney of Saffron Walden has worked out a specific scheme of crop rotation by means of which he has successfully rid his own land of the pest. Details of the method are given in *Agriculture*, 49, 155 (1943). The essential features of the scheme are: (1) a succession of spring-sown crops for six years, the first of which should be potatoes or roots, there being two cleaning crops during the first three years, and (2) the omission of autumn sown crops or bare fallow. The time of ploughing is specifically stated, and this must be rigidly adhered to in order to give the plants a check when most vulnerable. Drainage is also important. Seven rules of procedure are given with the reasons why they should be followed, and provided the farmer has sufficient perseverance to carry out the instructions, there seems every hope that his efforts will be attended with permanent success.

History of the Tomato

A SHORT paper on "The Evolution of the Cultivated Tomato" by Dr. L. C. Luckwill (*J. Roy. Hort. Soc.*, 68, Pt. 1; January 1943) shows that only one of the six species of the genus Lycopersicum is cultivated, though several wild kinds have supplied parentage for improvement by hybridization. Most primitive forms belong to the sub-species *Galeni* of *Lycopersicum esculentum*, and a good deal of improvement by selection was probably done by the natives of South America. The plant was first cultivated in Europe on the coastal plains of Spain and Portugal about 1535 A.D., spreading via Italy and Holland to Great Britain. This early cultivation yielded irregular, fasciated fruits, which were the typical produce until more than three centuries later. The change to a regular fruit is thought to have arisen as the result of a reverse mutation from the recessive to the dominant condition. Suggested lines for future improvement are the attainment of hybrid vigour (heterosis) by the crossing of well-chosen parents.

Co-operation in Research

RESEARCH workers will be interested in the way in which the method of co-operation in scientific investigation has been developed at the Franklin Institute (Reports of the Biochemical Research Foundation of the Franklin Institute, 6, 1940–41). The department has heretofore been the unit for achieving co-operation, and in an endeavour to attain closer correlation, the rigid division into departments has been eliminated. Under the new scheme, a round-table conference takes the place in part of the former department heads. Each member of this conference represents the group engaged in one particular phase of research, so that in this way a fan-like arrangement results in which all radii converge upon a focal point, the director. This enables the individual investigator to exercise his initiative and ability while at the same time the director is closely connected with each worker and each investigation. One example, with far-reaching therapeutic possibilities, that of the discovery of a substance from soil bacilli which inhibited the encapsulation of Friedländer's bacterium and at the same time was highly bactericidal for Gram-positive micro-organisms, is given to illustrate the value of co-operation in research. This substance, discovered by a microbiologist, was at first obtained in crude form; it was passed to the bacteriologists and cytologists to determine its qualities and powers, to the microchemists for analysis, identification and determination of probable composition, to the organic chemists for fractionation, to the spectroscopists for characterization, to the cytologists for toxicity, to the microscopists for record of crystalline struction, to the physical chemists for determination of its constants and further study of its structure, and to the surgeons for study of its external effects on badly infected wounds. The Foundation moved, in December 1940, from Philadelphia to new laboratories at Newark, Delaware, which contain wings to house such physical aids to research as a cyclotron. These laboratories were planned from the point of view of co-operation and co-ordination of research workers of various phases of chemistry, physics, enzymology, biology, cytology and medicine, so that a united effort may be made along one front for the advancement of science and the benefit of mankind.

Electricity Supply Tariffs

C. T. Melling, in a paper on "General Factors Affecting the Unification of Electricity Supply Tariffs" read on February 4 before the Institution of Electrical Engineers in London, discusses the general requirements of tariffs, and the fundamental aspects of the demand for electricity. The charge for electricity should be based on service value more than on the cost of supply, but there should be suitable controls to safeguard the individual consumer. The limitations of cost analysis in tariff-building are discussed, and it is pointed out that the need for more information on marginal costs demands more intensive research. The difference in the cost of supply in various undertakings, due to differences in bulk-supply charges and in types of area and load, has an important bearing on tariff unification, and a close examination of the economic and social implications of uniformity of charges throughout Great Britain is desirable before a definite decision is made on this matter. Small supplies to domestic and business premises are discussed in relation to the influence of non-monetary factors, as is also the space-heating load and the need for improvement in the bases of the fixed charges in two-part tariffs. Suggestions are outlined for a uniform system of tariffs, and an appendix to the paper contains an analysis showing the difference in cost of supply between urban and rural areas.

Electrical Aspects of Ferro-Alloy Manufacture

H. A. Sieveking (*J. Inst. Elec. Eng.*, 90, Pt. 2 No. 13; February 1943) has discussed the use of, and the power supply to, the submerged-arc electric furnace in connexion with ferro-alloy manufacture. The principal ferro-alloys, the method of grading and their uses are first summarized, and representative electricity consumptions per ton of finished alloy are given. In order to indicate the magnitude of the load, statistical information regarding the quantity of electrically manufactured ferro-alloys is next given over a period of years. This is followed by a description of the type of furnace used, together with brief notes on the electrical equipment and details of the electrodes. In order to indicate the importance of electricity costs, the selling price of typical ferro-alloys is given and, for comparison, the proportion of the selling price represented by each tenth of a penny per kWh. It is also pointed out that supplies of raw material are as easily available in Great Britain as they are in the major ferro-alloy producing countries, namely, Norway, Sweden, and the United States.

In order to establish the price at which electricity can be made available, typical costs of production for a 50,000 kW. steam station are given and, on 1939 costs, a price of ½*d.* per unit is arrived at. A comparison is also drawn with hydro-electric power and it is shown that, for equality of production costs, all other things being equal, the capital expenditure in a hydro-electric station could be as high as £72 per kW. installed. The disadvantages of a number of private generating stations are obvious, and it is shown that an electricity supply obtained from the Grid is more advantageous. Finally, some typical costs of production for ferro-alloys are given. It is contended that the introduction of a full ferro-alloy industry into Great Britain would offer to the electrical industry a load of some 500 million kWh. per annum, which would require a maximum demand of 75,000 kW. These electricity requirements would have to be made available at a very low price in order that the selling price of the imported alloy should not be exceeded. Employment would not be large as a result of this industry, but the protection which the steel industry would have through the vital ferro-alloys being readily available at all times would appear to be sufficient justification for giving careful consideration to the possibility of establishing ferro-alloy factories in Great Britain, more particularly when it is borne in mind that the furnace used can be adapted readily at any time to the manufacture of calcium carbide, an equally important raw material which in pre-war days was largely imported.

New Reference Frequency Equipment

According to V. J. Weber (*Bell Lab. Rec.*, 21, No. 3; November 1942) frequencies in radio and carrier telephone are now held constant to a very high degree of precision, and for the manufacture of radio and telephone apparatus it has been necessary to develop frequency standards of even greater precision. For the Hawthorne plant of the Western Electric Co., the Bell Laboratories have recently developed new reference frequency equipment which is interesting as an embodiment of the most modern technique. This equipment provides frequencies, accurate to two parts in ten million, of 100, 10, 1·0 and 0·1 kc., which may be distributed as desired about the Hawthorne plant. It also includes apparatus to detect any errors in these frequencies, and in such cases to give an alarm if the error exceeds a certain very low value. Two independent reference frequency supplies are provided, which is advantageous in making equipment available should trouble develop in one source. It also enables a continuous check to be maintained of the difference between the frequency of the two sources, and thus gives prompt indication of any incipient trouble.

A basic frequency of 100 kc. is generated by an oscillator circuit in an upper panel, and immediately below this is a 100 kc. amplifier. Below this again are three panels, producing submultiple frequencies of 10 kc., of 1 kc. and of 100 cycles. Another bay is provided for frequency checking which, besides providing for comparing the two frequencies with each other, also permits either to be checked against a standard 5 mc. frequency sent out over Station *WWV* by the National Bureau of Standards in Washington. A further bay provides independent power supplies for each of the three units. Power is taken at 117 volts and 60 cycles from the commercial supply, and from it four units produce regulated D.C. for plate supply, while a fifth unit supplies regulated A.C. heater voltage. There is one D.C. power supply for each of three bays, while a fourth serves as a spare, and may be connected in place of any of the other three by running cords between them.

Preservative for Telephone Poles

To be effective in prolonging the life of wood in contact with the ground, water-soluble materials must undergo a change after injection which will render them insoluble while retaining their preservative value. An article by C. M. Hill (*Bell Lab. Rec.*, 21, No. 3; November 1942) discusses a new preservative, now known as 'greensalt'. The composition mostly used contains potassium dichromate, copper sulphate and arsenic acid in solution. Variants include sodium dichromate as a substitute for the potassium salt, and also mixtures of chromic acid, copper carbonate and arsenic acid. These preservatives, particularly the first one, have been given extensive laboratory tests to determine their preservative value in wood and their permanence.

Small blocks of southern pine sapwood were impregnated with solutions of graded concentration and afterwards subjected to the attack of wood-destroying fungi under controlled laboratory conditions. Blocks similarly impregnated were subjected to exhaustive leaching, and the leach waters were analysed for copper, chromium and arsenic; the leached blocks were then exposed to fungus attack. The tests showed that greensalt became almost completely insoluble within a short time after injection, and both leached and unleached blocks satisfactorily withstood fungus attacks. Outdoor exposure tests on southern pine saplings 1 in. in diameter and posts 4–5 in. in diameter treated with greensalt were begun in 1934 under conditions very favourable to rapid destruction of wood in contact with the ground. The seven-year record of exposed specimens treated with ½ lb. and 1 lb. of greensalt preservative per cu. ft. of wood is excellent in comparison with simultaneous similar tests of preservatives of established standing, including creosote.

Wood Pigeon Investigation

THE report of the Edward Grey Institute's wood pigeon investigation in 1942, recently issued in the Wood Pigeon Bulletin No. 4, makes interesting reading in view of the concern over this bird's damage to war-time crops, for 1,734 nests were recorded on habitat cards and 32,276 birds recorded in field counts in the first six months of the year. Comparison is made between 458 nests recorded from northern England and 1,084 from the south, and the seasonal distribution of the percentage of nests respectively was, after May 31, 91 and 86; after June 30, 67 and 68; after July 31, 37 and 45; after August 31, 14 and 19. Two thirds of the nests were found after June 30, confirming earlier indications of the species' late breeding habits. Of the field counts, only a quarter were on clover and just over a quarter on corn, and over the whole country, on the average, the greatest number of wood pigeons was seen in January and February, after which there was a steady decline, the June figures being only one fifth of the February peak. More birds were recorded per observer in the south than in the north, but the maximum was in the Midlands. Regarding the wild food of these birds, phenologists of the Royal Meteorological Society record that, partly owing to the absence of late frosts in 1942, both oaks and beeches fruited more plentifully than in 1941; oaks fruited best in the north and west, and beech fared worst in the south. A plague of caterpillars in May, it is noted, may cause wood pigeons some six months later to turn their attention to cultivated crops.

Staffordshire Ecology

THE 1942 report issued by the East Staffordshire Branch of the British Empire Naturalists' Association contains recorders' reports on the faunal and floral survey conducted during the year at four selected localities—Sutton Park, Hopwas Woods (Tamworth), Randan Woods, and Minworth Sewage Works. In the Randan Woods lists, F. Fincher includes the badger, winter siskins, the nightingale and nuthatch, a male golden oriole on May 26, but the nightjar has disappeared as a nesting species. Butterflies are increasing, notably wall brown, comma, the pearl-bordered fritillaries, speckled wood, large skipper, while rare records in 1942 included the wood white and white-letter hairstreak. Seven species of Bombus (Hymenoptera), four of Vespa and three of ants were noted. Of the flora, adder's tongue fern and twayblade have increased. N. Grove and M. H. Asterley record as visitors at Minworth Sewage Works many duck and waders, the reed warbler nesting, 119 house-martin nests under the eaves of a power house the roof of which was burnt out during the previous winter. Major A. de Hamel's lists for Tamworth note an increase of jackdaws, jays, spotted flycatchers and swifts, and a decrease of swallows, house martins, and wood pigeons. The willow tit is included. Grasshoppers, dragonflies, beetles and fungi are also listed in the reports of the recorders, and there are notes from some other localities, including white helleborine at King's Norton.

Mythology of Cancer Research

UNDER this heading, the *Lancet* of December 26 has an article by Prof. E. L. Kennaway, who states that the literature of cancer research contains frequent references to an alleged piece of evidence for the carcinogenic action of arsenic recorded by Dr. J. A. Paris, F.R.S., senior physician to Westminster Hospital, in a book entitled "Pharmacologia", which reached its third edition in 1820 and its fifth in 1822. According to Paris, the poisonous effects of arsenic were seen in horses and cows, which lose their hoofs, while the latter suffer from a cancerous affection in their rumps. Seventy years after the appearance of the fifth edition of Paris's book, Mr. Henry Butlin, surgeon to St. Bartholomew's Hospital, made elaborate investigations into the truth of Paris's statements about the carcinogenic action of arsenic on animals but without finding the smallest evidence of their truth. Later writers, such as Hueper, Nieberle, Prehl and Hofmann, refer to Paris's statements but without bringing any evidence as to the occurrence of cancer in animals being due to arsenic. Prof. Kennaway comes to the conclusion that statements such as those of Paris should be fully investigated before they become incorporated in text-books.

Panamerican Sanitary Congress

AN article in the November issue of the *Boletín de la Oficina Sanitaria Panamericana* states that a very high place must be given to the Panamerican Sanitary Congress, which was held in Rio de Janeiro during September 7–18, 1942. Every Republic of South America was represented, and all, with one exception, by specialists including directors and professors of hygiene and authorities on tropical medicine, venereal disease, malaria, tuberculosis, bacteriology, radiology, forensic medicine, dietetics, aerial quarantine, dermatology and public health administration in general. The United States delegation consisted of six members, that of Paraguay eight and that of Chile ten, while that of Brazil was naturally larger. The Dominion of Canada was represented for the first time. The problems discussed consisted of the role of public health in the defence of the hemispheres, followed by more or less closely connected subjects such as malaria, typhus, nutrition, plague, influenza, tuberculosis, quarantine, yellow fever, trypanosomiasis, dysentery, cancer, heart disease and sanitary engineering. Caracas, Venezuela, was selected as the site for the next Congress, which is to be held in 1946.

Hospital Admissions in U.S. Rural and Urban Areas

THE issue of *Public Health Reports* of October 30 contains an interesting survey by Selwyn D. Collins, principal statistician, United States Public Health Service, of variation in hospital admissions with the size of city, family income and other environmental factors. The survey is based on records for 8,758 families in 130 localities in eighteen States. Hospital rates were lower for rural than for urban areas, and were lower for small towns than for large cities. In cities the highest rates for admissions and days of hospital treatment occurred in the highest and lowest income groups, while in rural areas the lowest income group had the lowest hospital rates. The lowest income group in both urban and rural areas had the lowest average days per hospital case. Four important diseases were responsible for about half of all the admissions to hospital, namely, tonsillectomy, deliveries, appendicitis and accidents. The first three diseases tended towards higher percentages of cases admitted to hospital in the higher income-level. In the percentage of cases admitted to hospitals, deliveries showed the largest and most regular increases with income.

Mycological Nomenclature

CHANGES in the naming of a species following increased knowledge can be very confusing, but teachers and students who require a clear statement of the rules of nomenclature as they affect mycology will find it in a series of four short papers by Miss E. M. Wakefield, E. W. Mason, G. R. Bisby and J. Ramsbottom (*Trans. Brit. Mycol. Soc.*, **25**, Pt. 4, pp. 428–439; December 1942).

Announcements

OWING to the generosity of the Rockefeller Foundation which has for a third year in succession provided a grant for the purpose, the Royal Society is in a position to give some assistance to scientific societies and associations which, as a result of war conditions, are experiencing financial difficulties in the publication of scientific journals.

THE University of Leeds has accepted a gift of £50,000 from Mr. Henry Ellison, to create an endowment fund for the provision of post-graduate fellowships for research in pure and applied chemistry and in physics.

AT the annual general meeting of the Society of Public Analysts and Other Analytical Chemists held on March 3, the following were elected officers and council for the coming year: *President:* S. Ernest Melling; *Past Presidents serving on the Council:* F. W. F. Arnaud, Bernard Dyer, John Evans, Edward Hinks, E. B. Hughes, G. Roche Lynch, W. H. Roberts and G. Rudd Thompson; *Vice-Presidents:* H. E. Cox, G. Hogan, T. Rendle, W. Gordon Carey (chairman, North of England Section) and A. R. Jamieson (chairman, Scottish Section); *Hon. Treasurer:* George Taylor; *Hon. Secretary:* Lewis Eynon; *Other Members of Council:* J. W. Corran, R. H. Ellis, J. G. A. Griffiths, D. W. Kent-Jones, R. Lessing, H. M. Mason, B. G. McLellan, M. Pearson, W. H. Simmons, R. W. Sutton, E. Voelcker, K. A. Williams, Arnold Lees (hon. secretary, North of England Section) and R. S. Watson (hon. secretary, Scottish Section).

A NEW editorial board of *Endocrinology* has been appointed as follows: J. S. L. Browne, Department of Medicine, McGill University; E. T. Engle, Department of Anatomy, College of Physicians and Surgeons, New York; Carl G. Hartman, Department of Zoology, University of Illinois; E. C. Kendall, Division of Biochemistry, Mayo Clinic; F. C. Koch, Department of Biochemistry, University of Chicago; C. N. H. Long, Department of Physical Chemistry, Yale University School of Medicine; and H. B. van Dyke, Squibb Institute for Medical Research. The managing editor is E. B. Astwood, of the Departments of Medicine and Pharmacology, Harvard Medical School; the associate managing editor is E. W. Dempsey, of the Department of Anatomy, also of Harvard Medical School.

A RESEARCH scholarship of the value of £400 per annum and tenable for two years has been offered by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a Committee of the Institution of Naval Architects and it is hoped to make the award in September next. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Physiological Action of Acetic Acid in Living Tissues

STARTING from the general thesis that volatile acids are produced in large quantity in the rumen of the sheep, McAnally and Phillipson[1] showed that some at all events of these acids are absorbed from the rumen and are found in considerably greater quantities in the blood coming from that organ and from the large intestine than in the blood coming from other parts of the alimentary canal.

They showed further that of the acids so absorbed acetic appears to be the preponderant one.

The fate of acetic acid then demands consideration. Among other possibilities is that of its being destroyed in the tissues. To test this the mammalian (rabbit's) heart was perfused with Locke's solution in which, for the glucose, sodium acetate was substituted.

As the accompanying table shows, the sodium acetate disappeared on the same sort of scale as Locke and Rosenheim[2] found glucose to be consumed.

Serial number	Weight of heart (gm.)	2-hour period	Acetate introduced at the commencement of each 2-hour period (mgm.)	Acetate disappearing in 2-hour period (mgm.)	Remarks
1	2·8	1st period	134	56	
		2nd ,,	,,	52	
		3rd ,,	,,	28	
2	5·35	1st ,,		28	Heart not beating
3	4·60	1st ,,	,,	66	
		2nd ,,	,,	54	
4	5·2	1st ,,	,,	36	1·7 mgm. acetate recovered from heart at end of exp.
		2nd ,,	,,	34	
5	4·6	1st ,,	141	54	0·8 ,, ,,
Controls in which the heart was replaced by a piece of rubber tubing.					
1	—	—	134	5	
2	—	—	134	4	

That acetate has some merit, however, under the conditions of our experiments, is shown by the fact that, whereas we have maintained the hearts beating up to 4–6 hours on solution containing acetate, on the same solutions, free of acetate, they have not beat for more than two hours.

Whether or no the acetic acid is oxidized is under investigation, but whatever its fate may be, the fact that it does disappear opens wide fields for speculation.

JOSEPH BARCROFT.
RACHEL McANALLY.
ANDREW PHILLIPSON.

Unit of Animal Physiology,
at Department of Physiology,
University,
Cambridge.
Feb. 24.

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[1] McAnally, R., and Phillipson, H. T., *Proc. Physiol. Soc.*; *J. Physiol.* (in the press).

[2] Locke, F. S., and Rosenheim, O., *J. Physiol.*, 36, 205 (1907).

Structure of Keratin Fibres

THE chief studies of keratin fibres have been carried out on wool and human hair. In these cases cortical cells constitute the bulk of the fibre substance, and readily lend themselves to physico-chemical examination[1]. The majority of mammalian fibres, however, are heavily medullated and possess a cuticular layer which may vary in thickness from 3 μ to 10 μ. A study of different types of animal fibres has shown that this histological differentiation is paralleled by chemical reactivity. The following results, obtained on treating transverse sections[2] of Kolinsky (*Mustela Siberica*) guard-hairs with various reagents, are representative of the chemical characteristics of cuticle, cortex and medulla.

Reagent	Result
5% NaOH. 2 hr. 22·2° C.	Cuticle partially attacked, complete solution of cortex, medulla undamaged.
5% $Na_2S.9H_2O$. 18 hr. 22·2° C.	Cuticle swollen and showing platelet structure, almost complete solution of cortex, medulla intact.
Chlorine water. 15 min. 22·2° C.	Cuticle very swollen and separating into platelets, cortex and medulla intact.
4*N*.HCl. 10 min. boil → 5% aq. Sod. Naphthaquinone-4-sulphonate. 18 hr. 22·2° C.	Faint colour in cuticle, very intense coloration in cortex, medulla colourless.
Millon's Mercury Reagent. 18 hr. 22·2° C.	Faint colour in cuticle and cortex, intense colour in medulla.
Van den Bergh's Diazo-Reagent. 18 hr. 22·2° C.	Faint yellow colour in cuticle and cortex, more intense colour in medulla. Colour apparently unchanged by Totani histidine test.
0·25% Trypsin. *p*H 8·5. 35° C.	Complete solution of medulla after 15 min., cuticle and cortex intact after 3 weeks' treatment.

It will be noticed that sodium hydroxide and sodium sulphide, reagents which cause fission of the disulphide bond[1], are most reactive with those parts of the fibre which the Sullivan test shows contain the greater proportion of cystine. The major portion of reactive tyrosine is located in the medulla region.

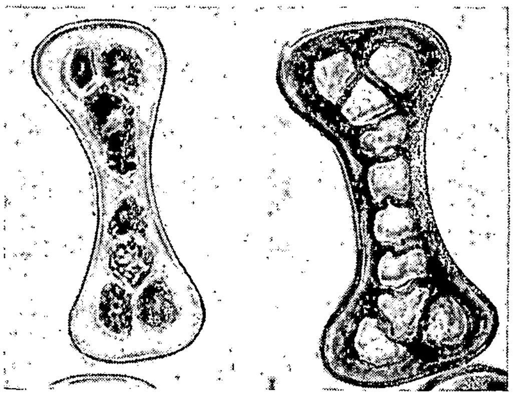

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Fig. 1.

When transverse sections of guard-hairs from the Russian hare (*Lepus variabilis*) are dyed in neutral or acid solutions of basic dyes, the dye is absorbed preferentially by the medulla. Uniform dyeing results from an alkaline bath. Acid dyes in neutral solution dye only the cortex, but in acid solution dye both cortex and medulla. Fig. 1 shows the

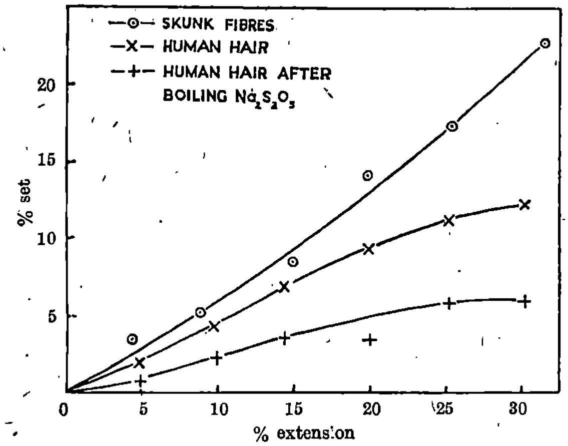

Fig. 2.

results obtained after (*a*) 1 hr. in boiling 0·1 per cent Safranine *B*, (*b*) 1 hr. in boiling 0·1 per cent Kiton Red G. Ermine (*Mustela erminœ*) fibres behave in a similar fashion.

The physico-chemical properties of mammalian guard-hairs also are different from those of human hair and Cotswold wool. White fibres from the skunk (Mephitis), degreased and boiled under tension in 2 per cent borax for 30 min., attain a greater permanent set than do human hair fibres, and in the former case the set is stable to boiling 5 per cent sodium metabisulphite solution (Fig. 2). Untreated skunk fibres also show much smaller supercontraction than is observed with wool or human hair. X-ray diffraction patterns, kindly photographed by Dr. K. M. Rudall, suggest that this difference in setting properties of skunk fibres and human hair is not due to the presence of different amounts of crystalline keratin. The orientation of polypeptide chains in the cuticle, together with the value of the cuticle/cortex ratio, are probably the factors governing setting and supercontraction in mammalian guard-hairs.

A more detailed account of these experiments will appear elsewhere.

J. L. STOVES.

University,
Leeds. Feb. 12.

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[1] Stoves, J. L., *Trans. Farad. Soc.*, 38, 254, 261, 501 (1942).

[2] Stoves, J. L., *Analyst*, 67, 385 (1942).

Isomers of Stilbœstrol and its Esters

IN the course of experiments on the synthetic œstrogens, it became evident that the substance, m.p. 140–142°, obtained by Dodds, Golberg, Lawson and Robinson[1] from the liquid modification of 4 : 4′-dimethoxy - α : β-diethylstilbene, and hitherto considered to be an isomer of stilbœstrol (4 : 4′-dihydroxy - α : β-diethylstilbene)[1,2], was probably a mixture.

Similar material, m.p. 140–144°, which analysed as for stilbœstrol, on extended fractionation from benzene, has now yielded two substances: (1) stilbœstrol crystallizing from benzene in long needles, which break down on drying to an amorphous white powder, m.p. 171°, and (2) hexagonal tablets of apparently pure ψ-stilbœstrol, stable on drying and melting at 151° (I). The accompanying m.p. diagram leaves little doubt as to the purity of the latter compound, whereas the material, m.p. 140–142°, is seen to be approximately a eutectic mixture, containing 60 per cent ψ-stilbœstrol and 40 per cent stilbœstrol. Pure ψ-stilbœstrol can be converted into stilbœstrol in 80 per cent yield by heating with alcoholic hydrochloric acid.

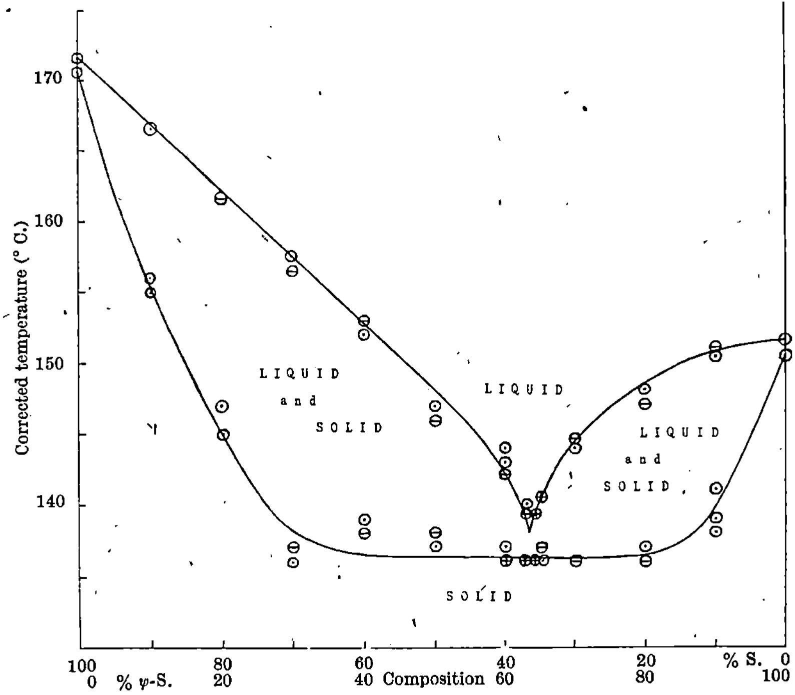
The esterification of stilbœstrol and ψ-stilbœstrol has also given some interesting results. Stilbœstrol, on treatment with propionic anhydride, yielded, in addition to the known dipropionate (hexagonal prisms, m.p. 107–108°), a second dipropionate (III) (long needles, m.p. 78–79°) by extended fractionation of the second crops from alcohol. The ester, m.p. 78–79°, on boiling (390°) for ½ minute at normal pressure, was partly converted into the dipropionate, m.p. 107–108°. On reduction, it gave a theoretical yield of hexœstrol dipropionate, m.p. 126–128°, whereas the ester, m.p. 107–108°, on similar treatment, gave only an oil from which hexœstrol dipropionate was isolated in small yield. On the other hand, both dipropionates from stilbœstrol gave theoretical yields of the latter on alkaline hydrolysis.

ψ-Stilbœstrol, m.p. 151°, on similar esterification, yielded an oily dipropionate (II), b.p. 255–256°/10 mm., from which a theoretical yield of ψ-stilbœstrol was recovered on alkaline hydrolysis. This oil may prove to be a mixture analogous to that obtained from stilbœstrol.

The comparative biological activities of the three

	Standard			Test	Ratio of Activity to Standard
	Stilbœstrol, m.p. 171°			(I) ψ-Stilbœstrol, m.p. 151°	
Total dose injected	0·8 μ gm.	1·6 μ gm.	3·2 μ gm.	40 μ gm.	
Response of uteri in mgm. ± S.D.	98·0 ± 15	108 ± 14	120 ± 29	118 ± 21	1/14
	Stilbœstrol Dipropionate, m.p. 107–108°			(II) ψ-Stilbœstrol Dipropionate oily	
Total dose injected	0·2 μ gm.	0·4 μ gm.	0·8 μ gm.	10 μ gm.	
Response of uteri in mgm. ± S.D.	39 ± 8	51 ± 3	68 ± 16	63 ± 13	1/16
	Stilbœstrol Dipropionate m.p. 107–108°			(III) Stilbœstrol Dipropionate long needles, m.p. 78–79°	
Total dose injected	0·8 μ gm.	3·2 μ gm.		500 μ gm.	
Response of uteri in mgm. ± S.D.	109 ± 19	129 ± 8		99 ± 11	1/600
Total dose injected	0·4 μ gm.	1·6 μ gm.		250 μ gm.	
Response of uteri in mgm. ± S.D.	83 ± 12	109 ± 8		84 ± 13	1/625

compounds, identified by the numbers (I), (II) and (III), are given in the accompanying table. The method of assay was that in which uteri are dissected, fixed and weighed. Several assays, of which four are recorded, have been made on each sample. The figure previously reported by Dodds *et al.* for ψ-stilbœstrol corresponded to approximately one third the activity of stilbœstrol; our figure of one fourteenth is in accord with the findings reported here. The biological inactivity of compound III, stilbœstrol dipropionate, m.p. 78–79°, arouses speculation as to its possible structure.



⊙, 1 observation; ⊖, 2 identical observations; ⊕, 3 identical observations.

Corrected Melting Points
Stilbœstrol-ψ-Stilbœstrol Mixtures.

% S	% ψ-S	1	2	3
100	0	170·5–171·5°	—	—
90	10	155–166·5°	156–166·5°	—
80	20	147–161·5°	145–161·5°	–161·5°
70	30	136–156·5°	137–157·5°	137–156·5°
60	40	139–153°	138–152°	138–153°
50	50	137–146°	138–146°	138–147°
40	60	136–144°	136–142° (2)	137–143°
37	63	136–140°	136–139·5°	136–139·5°
36	64	136–139·5	136–139·5°	136–139·5°
35	65	137–140·5°	137–140·5°	136–140·5°
30	70	136–144°	136–144·5°	–144·5°
20	80	137–147°	136–148°	136–147°
10	90	141–151°	138–150·5°	139–151°
0	100	150·5–151·5°		

Further work is in progress on the configuration and activity of these and similar compounds, especially in the light of the results of Wessely *et al.*[2,3], and it is hoped to publish a more detailed account later.

E. WALTON.

Wellcome Chemical Works,
Dartford.

G. BROWNLEE.

Wellcome Physiological Research Laboratories,
Beckenham.

THE question of the homogeneity of stilbœstrol and pseudostilbœstrol has been studied by us in a preliminary fashion, and we concur in the conclusions of the above communication. So far our purest pseudostilbœstrol has mp. 148°, and is evidently still not quite pure. Its biological activity has not yet been assayed.

E. C. DODDS.
R. ROBINSON.

Loss of Phosphorus during Sewage Purification

THE importance of conserving the world's resources of phosphorus has recently been under discussion. The two main causes of depletion are the loss of phosphates from soil by leaching, and the loss of phosphorus compounds contained in sewage. We have completed a preliminary examination of the removal of phosphorus from sewage during purification and obtained results which may be of general interest.

Sewage and garbage are usually disposed of by different methods and at different sites; and since the quantity of phosphorus retained by the human organism is extremely small as compared with that contained in the diet, the phosphorus in sewage, particularly that contained in the sewage which is derived from a residential area, represents closely the amount of the element actually consumed. Some of the results we have obtained might therefore be of special interest to dietitians.

At the Coleshill sewage works of the Birmingham Drainage Board, which purifies the sewage from about 110,000 inhabitants of a residential district, the total phosphorus in the sewage before purification was equivalent to 1·3 gm. phosphorus per head of population per 24 hours. The purified sewage which passed to the River Tame contained 54 per cent of the phosphorus present in the crude sewage, the remainder being accounted for by the phosphorus retained by the sewage solids recovered as a sludge. These figures must at present be regarded as tentative, since under war-time conditions it is difficult to assess the population with accuracy.

The Middlesex Main Drainage Works at Mogden serves a population of rather more than 1,200,000. The sewage draining to this works contains a proportion of phosphorus compounds from certain industries, but this proportion is very small as compared with that which is domestic in origin; and moreover, this small proportion can be fairly accurately measured. Over a period of one month the total phosphorus in the crude sewage derived from both industrial and domestic sources was equivalent to 1·56 gm. phosphorus per head per 24 hours, of which, it has been estimated, 1·51 gm. represents the amount consumed in the diet. The purified effluent discharged to the

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[1] Dodds, Golberg, Lawson and Robinson, *Proc. Roy. Soc.*, **127**, 140 (1939).

[2] Wessely and Kleedorfer, *Naturwiss.*, **27**, 567–568 (1939).

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River Thames contained the equivalent of 0·62 gm. phosphorus per head per day. In this case 40 per cent only of the phosphorus present in the crude sewage passes to the river, and 60 per cent is retained in the sludge.

It is interesting to note that the total amount of phosphorus excreted is given by Fowler[1] as 1·48 gm. P per head per day; Mathews[2] gives the phosphorus ingested in the food of an adult as 1·2–2·0 gm. P per day, while Sherman[3] regards 1·5 gm. P per day as the lowest intake compatible with safety for the adult.

Armstrong[4] gave the phosphorus in the sewage from Great Britain as equal to 150,000 tons of rock phosphate a year and stated that most of this reached the sea. On the basis of the figures we have obtained, the amount of phosphorus in sewage from a population of 42 million inhabitants is equivalent to about 116,000 tons of calcium phosphate per annum, and by suitable treatment of the sewage, 46–60 per cent of this could be recovered in a usable form.

We hope to make a more detailed study of this subject when circumstances permit in order to supplement the information we already possess, and to extend our investigations by a study of the losses of phosphorus and nitrogen during sewage purification.

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Mogden Sewage Purification Works,
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[1] Fowler, G. J., "An Introduction to the Biochemistry of Nitrogen Conservation" (London, 1934), p. 247.

[2] Mathews, A. P., "Physiological Chemistry" (New York, 1924). 3rd Edit., p. 755.

[3] Quoted by Lester, J. S., "Nutrition and Diet in Health and Disease" (London, 1934), 2nd Edit., p. 121.

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Breeding of a Cotton Immune from Natural Crossing

Balls ("The Cotton Plant in Egypt", 1912) made the discovery that in the cotton plant, self pollen was somewhat prepotent over foreign pollen, in interspecific crosses between Egyptian cotton (*Gossypium barbadense* L.) and Upland cotton (*G. hirsutum* L.). Thus if stigmas of *barbadense* were pollinated with a mixture of *barbadense* and *hirsutum* pollen, most of the ovules were fertilized with *barbadense*. The reverse was found with *hirsutum*. The prepotency of self pollen over foreign pollen was rediscovered by Jones some years later in maize, and other plants are now known to follow this rule.

But Balls went further and showed that some F_1 pollen was prepotent over self pollen, though he did not deduce any theoretical consequences from this fact. This observation made me believe that in an interspecific cross there must be segregation for velocity of pollen tube growth conditioned by minor modifiers (now called polygenes by Mather). If there were many minor genes for velocity it should be possible to concentrate them by stringent selection and produce new types in which self pollen grew so rapidly that no foreign pollen would grow fast enough to fertilize.

The plan adopted was as follows, and the experiments lasted from 1929 until 1935, when I left Trinidad for Brazil.

The cross:

Upland:	y, cream corolla	*barbadense*:	Y, yellow corolla
	p, cream pollen		P, yellow pollen
	s, spotless corolla X		Sf, faint spot
	r, green plant body		R, red plant body

The F_1 showed dominance of Y, P and R. Sf could not be usefully employed because penetrance was too low.

The first backcross of F_1 on to the triple recessive hirsutum Upland.

The female triple recessive was selfed at 8 a.m., much pollen being applied. Afterwards F_1 pollen was applied at intervals of one hour later, two hours later, etc., to eight hours later.

Approximately ten bolls with roughly 210 seeds was the objective from each of the treatments.

The results. As my notes were all lost on leaving Trinidad I can only give very approximately the nature of the results.

It was found that a considerable number of F_1 pollen tubes could beat the self tubes even when the latter had four hours start. A hundred plants were grown from each treatment, making eight hundred plants in all. Approximately eleven plants of composition $R\ Y\ P\ r\ y\ p$ were secured from the four-, five- and six-hour treatments.

It would have been desirable to have tested each of these plants in a similar series of treatments to those given above, but time and space did not permit of this.

For the second backcross on to *hirsutum* triple recessive a mixture of pollen from all the eleven plants was used.

The second backcross results. The exact numbers are not available, but it may be said that a *much greater number of foreign tubes* were able to fertilize at the four-, five- and six-hour intervals.

The third backcross. The pollen of ten $R\ Y\ P\ r\ y\ p$ plants was mixed and applied at the same intervals after self-pollination.

The number of plants from foreign pollen was slightly superior to the number in the second backcross, and the whole population was Upland in most of its characteristics.

The self population. All plants resulting from the four-, five- and six-hour treatments, about sixty in number, were self-fertilized, and grown in progeny rows. All triple recessives were self-fertilized, to create a series of lines identical with Upland except for the presence of the rapid pollen tube genes.

Five plants only were available to continue the experiment. Progeny rows of the five were interspersed among a collection of mixed hybrids of *hirsutum*, *barbadense* and *purpurascens* ancestry.

If we had been successful in concentrating some of the rapid pollen tube growth genes, some plants in these five rows would breed true to type $r\ y\ p$ and vegetative characteristics and could therefore be termed immune to natural crossing.

Unfortunately the experiment was interrupted at this point, and has only recently been resumed. Its practical importance for application to other crops is too obvious to need emphasizing.

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Jan. 19.

An Exceptional Increase of Cosmic Rays?

IN a previous communication[1], an account was given of the hourly records of the intensity of cosmic rays which are being obtained by making use of a battery of Geiger counters registering threefold coincidences. No absorbing screens are used.

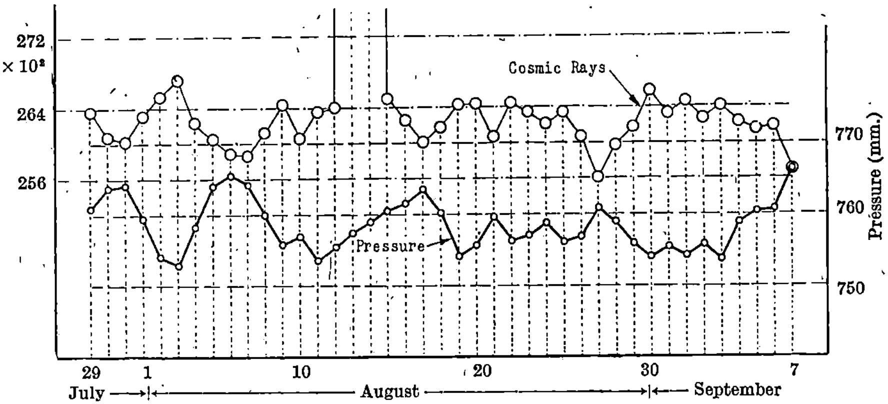

Fig. 2.

The records generally show that the changes in cosmic rays from day to day are more or less what can be expected from well-known geophysical influences. Nevertheless, last August a transient change was recorded which apparently cannot be ascribed to any of these influences. The points on the diagram of Fig. 1 represent the hourly counting rate for the period August 12–15, 1942. The scale is in percentages from the normal value. The rapid and quite unusual increase which began at about 18h. (G.M.T.) August 13 was preceded by fluctuations in the counting rate which are not common in the absence of magnetic activity. When these fluctuations were being observed it was considered advisable, in order to test the apparatus, to substitute a new pair of thyratrons for the first pair in the counting circuit. The point corresponding to 12h. on the diagram had already been observed after putting in the new valves. These were permanently retained, and the other parts of the apparatus had remained untouched.

As the diagram shows, the results of the first few observations made with the new thyratrons and those which follow the great increase are entirely comparable with the results of previous observations. To what extent this is true may be inferred from the diagrams in Fig. 2. The larger circles represent the averages of the hourly counting rate per day, and the smaller circles the corresponding average atmospheric pressures. Furthermore, the old pair of thyratrons was replaced a month later and again the results did not show any marked difference. In any event, it would be difficult to explain how so sudden, great and regular a change of pulse-rate could be the result of changing the valves. Thus everything seems to point to the conclusion that the relation in time between the substitution of valves and the sudden increase in counting rate was accidental. It thus becomes probable that the observed increase of pulse-rate actually represents an increase of cosmic rays.

However, it seems that this phenomenon cannot be explained by any unusual geomagnetic activity. From information kindly given by the Royal Observatory, Greenwich, it appears that the magnetic field remained perfectly calm during the period August 13–14, and that the only disturbances recorded, on August 10, 15–17, and 22–24, were slight, with a range in the horizontal magnetic force H of 110γ, equivalent to about − 0·6 per cent of the H value.

In order, therefore, to account for the great influx of particles, it would probably be necessary to assume that they entered the earth in the form perhaps of a stream superimposed on the ordinary cosmic radiation. With regard to their energy, they should have at least the minimum energy necessary for primary particles to produce any appreciable effect at sea-level. From the results obtained by Bowen, Millikan and Neher[2] at different latitudes in their investigation of the variation of cosmic ray intensity with altitude, and also from Lemaître-Vallarta's calculations[3], this lowest energy can be estimated to be about 5×10^9 eV. This is about the energy necessary for charged particles to reach vertically the magnetic latitude of 44°. Now from information kindly communicated by the Department of Terrestrial Magnetism, Carnegie Institution of Washington, no increase was recorded at Cheltenham, U.S.A. It is necessary, therefore, to assume that the secondaries produced at sea-level

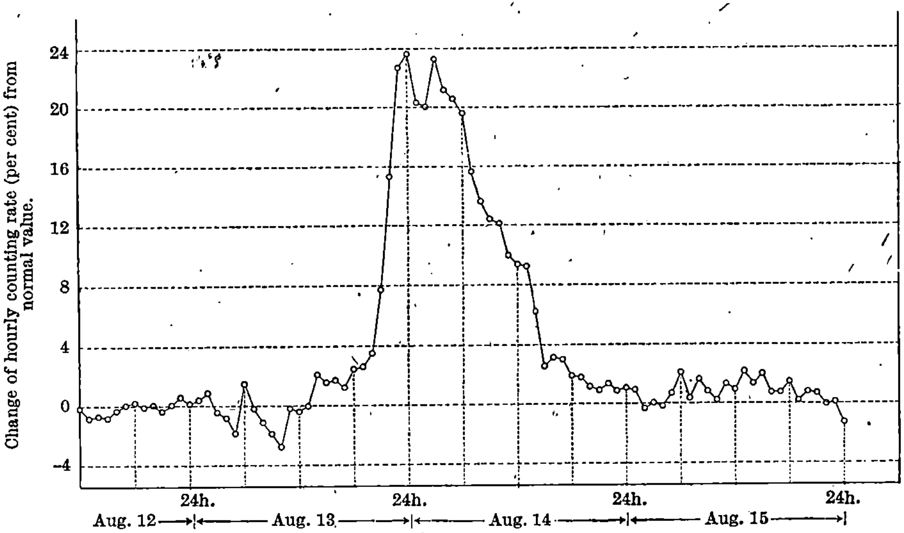

Fig. 1.

were only penetrating enough to pass through the counter set in London ($\lambda = 54°$), and too absorbable to penetrate the 12 cm. of lead shield which protects the ionization chamber in Cheltenham ($\lambda = 51°$). Consequently, it is probable that the energy of the abnormal primary particles did not extend much further than 6×10^9 eV. Owing to the absence of reliable counter measurements at magnetic latitudes higher than 44°, it is difficult to estimate the contribution of primaries of such an energy to the cosmic-ray intensity at sea-level. But it is obvious that the smaller this contribution is, the greater will be the proportion of new particles represented by the peak value of Fig. 1 in relation to the number of particles of the same energy at normal times. If the normal is, say, 1 per cent, then we have been receiving, during some hours of the night of August 13–14, a stream of more than twenty times the normal number of 5–6 $\times 10^9$ eV. particles.

Jánossy[4] and later Vallarta[5] have pointed out that the magnetic field of the sun may be responsible for the latitude 'cut-off' effect in the cosmic-ray energy spectrum incident on the earth. If so, one could imagine that on August 13–14 a disturbance of the sun's magnetic field occurred which allowed particles to reach the earth that otherwise would have been stopped. But according to Epstein's[6] calculations, in order to cut off particles of 5×10^9 eV., it would be necessary for the heliomagnetic field to be of a value much greater than 50 gauss, which is the upper limit obtained from spectroscopic measurements. Such a value is very unlikely.

So far as is known to me, there has never before been recorded so great an increase of cosmic rays which has extended for such a length of time. On August 17, 1941, our apparatus registered a quite abrupt increase of more than 30 per cent, which lasted only from 1h. until 3h. Also last March two sudden increases of about 7 per cent were recorded in Cheltenham[7] and London, which lasted not more than four hours each. But these were probably associated with magnetic storms.

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[1] Duperier, NATURE, **149**, 579 (1942).

[2] Bowen, Millikan and Neher, *Phys. Rev.*, **53**, 855 (1938).

[3] Lemaître and Vallarta, *Phys. Rev.*, **43**, 87 (1933).

[4] Jánossy, *Z. Phys.*, **104**, 430 (1937).

[5] Vallarta, NATURE, **139**, 839 (1937).

[6] Epstein, *Phys. Rev.*, **53**, 862 (1938).

[7] Lange and Forbush, *Terr. Mag.*, **47**, 185 (1942).

Composition of Chlorine Hydrate

THE composition of chlorine hydrate has been the subject of much experimental work. Faraday, by analysis, found the composition to be $Cl_2.10H_2O$. The composition has also been determined analytically by Roozeboom[1] who found $Cl_2.8H_2O$, Bouzat and Azinières[2] who found $Cl_2.6H_2O$, and more recently by Anwar-Ullah[3] who agreed with this last formula. De Forcrand[4] used an empirical rule to calculate the number of molecules of water present. According to de Forcrand's rule, if ΔH is the heat of dissociation of the hydrate into gaseous chlorine and ice, and T the temperature at which the dissociation pressure is 760 mm., then $\Delta H/T$ is a constant the value of which is approximately 30. The value of T is known from the dissociation pressures determined experimentally by Roozeboom, and this gives a value of ΔH equal to 8,478 cal./gm. mol. Since de Forcrand's rule is only an approximation, this value of ΔH is very inaccurate. De Forcrand determined the heat of dissociation of the hydrate into gaseous chlorine and water by measuring the heat of solution of the hydrate in water and obtained a value of 18,360 cal./gm. mol. The number of molecules of water present in the hydrate is then given by $n = 18{,}360 - 8{,}478/1{,}436 = 6\cdot88$, the latent heat of fusion of ice being 1,436 cal./gm. mol. De Forcrand therefore assumed the composition to be $Cl_2.7H_2O$.

The true composition of the hydrate can be found by calculating the heats of dissociation into gaseous chlorine and ice, and gaseous chlorine and water respectively, using the dissociation pressure data of Roozeboom[1]. The graph of log p against $1/T$ is found to be linear in both cases, and from the slopes of the two lines the heats of dissociation are respectively 6,413 and 17,870 cal./gm. mol. The number of molecules of water in the chlorine hydrate molecule is thus $17{,}870 - 6{,}413/1{,}436 = 7\cdot97$; and there is little doubt, therefore, that the correct formula is $Cl_2.8H_2O$.

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Feb. 12.

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[1] Roozeboom, *Rec. Trav. Chim.*, **3**, 68, 1884; **4**, 65, 1885.

[2] Bouzat and Azinières, *C.R.*, **77**, 1444 (1923).

[3] Anwar-Ullah, *J. Chem. Soc.*, 1172 (1932).

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Name for Element 85

MAY I be permitted to register a protest at the ungainly name suggested for element 85 by Mrs. A. Leigh-Smith and A. Minder[1]. The more science has been divorced from the humanities the more has mankind been afflicted by unpleasing words. Even so, this word 'anglo-helvetium' surely exceeds the limits of toleration. Assuming its existence to be confirmed and the chemistry of this element to be worked out, are we to talk of hydroanglo-helvetic acid (formula HAh perhaps) and of the peranglo-helvetates ? By comparison with the possibilities which might be made of anglo-helvetium, we may come to regard dysprosium and praseodymium as old friends.

I make no claim to special knowledge of the English or classical tongues, but it does seem reasonable to suppose that since the other halogens have been named so elegantly from the Greek, it might be possible to find a fairly short word similarly derived which could serve as a name for this last halogen. The word 'leptine' (Greek *leptos*) has been suggested to me, but I mention it merely to illustrate the sort of thing that might be done to provide a euphonious and reasonably short word which could be easily transcribed into the principal European languages.

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[1] NATURE, **150**, 767 (1942).

LEAF ANALYSIS AS A GUIDE TO SOIL FERTILITY

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ONE way of investigating agricultural soils is by leaf analysis. The fundamental idea behind this method is that the amount of nutrient salts absorbed by the plant reflects the available amount of these salts in the soil. Whereas earlier trials along this line dealt with the storage of salts in the mature plant, for example, hay, or in seedlings, leaf analysis is based on the functioning assimilating leaves as the central 'laboratories of nutrition'.

The concentration of salts in leaves is regulated by the absorption power of the roots; and the growth of the whole plant, including the formation of seeds, is again controlled by the transformation of the nutrient salts proceeding in the green, assimilating leaves. If samples of the leaves of cereals, potatoes, clover, etc., are collected at the flowering stage, the percentage of nitrogen, potassium, calcium and phosphoric acid in the dried material gives an expression of the available amounts of these nutrients in the soil (Fig. 1). The idea of leaf analysis has been worked out in my laboratory since 1929 and was first published in 1934[1]. In France and the United States, too, studies of leaf analysis ('foliar diagnosis') have been performed independently[2,3].

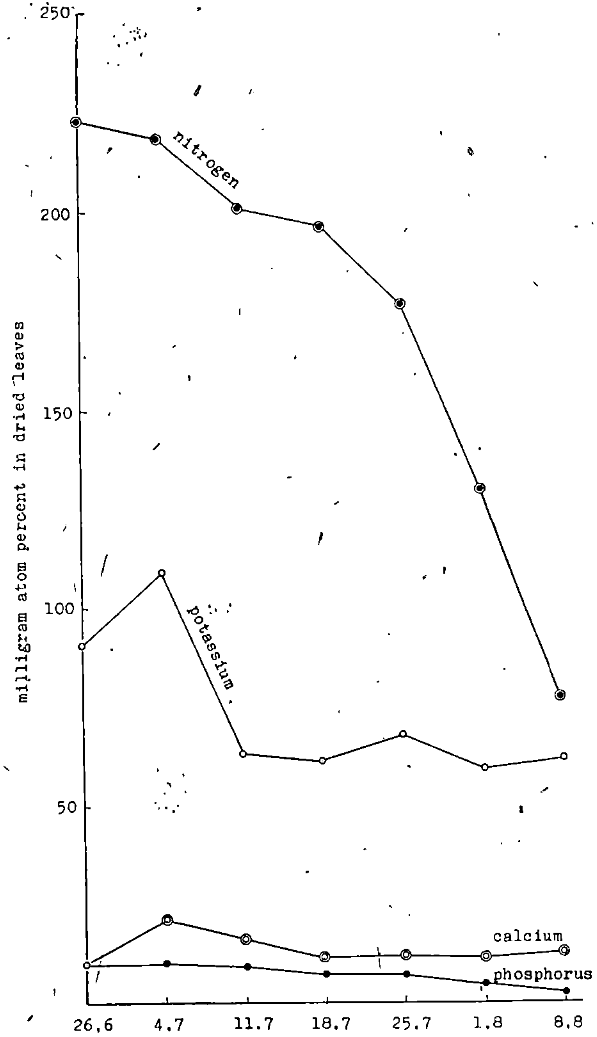

Fig. 1. THE CONCENTRATION LEVEL OF NUTRIENTS IN THE LEAVES OF WHEAT DURING THE VEGETATION PERIOD. FLOWERING OCCURS BETWEEN JULY 11 AND 18 (SUITABLE PERIOD FOR LEAF ANALYSIS).

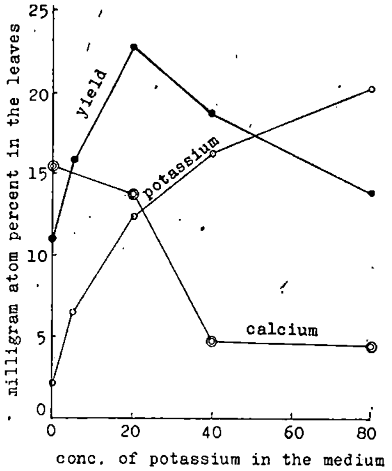

Fig. 2. ION ANTAGONISM BETWEEN POTASSIUM AND CALCIUM (OATS). INCREASE OF POTASSIUM IN THE PLANT SUPPRESSES THE ABSORPTION OF CALCIUM; AS A CONSEQUENCE THE YIELD DECREASES.

My idea of leaf analysis had its origin in the fact that, as shown by pot experiments and field experiments, each nutrient factor must be present in a certain minimum concentration in the green parts of the plant, unless the growth is to be seriously checked. It was furthermore demonstrated that, whereas in some cases the concentration of salts within the plant rises in proportion to the concentration in the medium, in some cases ion antagonism and other disturbing factors seriously derange these relations. It is a well-known fact that the accumulation of potassium within the plant suppresses the absorption of calcium, even if this element is present in normal amounts in the soil. If antagonism brings the inner calcium concentration down below the limit, the growth is inevitably retarded (Fig. 2). Such experiments were varied in several ways, and they always illustrated the thesis that the growth and yield of the plants are regulated by the amount of nutrient salts actually present in the green, assimilating parts of the plant. Leaf analysis is thus a sort of integration of all circumstances which influence the availability of the salts in the soil, and it includes also the nitrogen, one of the most prominent factors of nutrition. The determination of nitrogen by chemical analysis of the soil is misleading, because available nitrogen is continuously produced by micro-organisms, which get part of their nitrogen from the atmosphere.

The practical value of leaf analysis was tested by comparing the analytical data with the results of field experiments. During 1938 and 1939 about eight hundred such experiments were carried out in different parts of Sweden. Leaf analysis was made on samples from non-fertilized plots. These figures were compared with the difference in yield as between fertilized and non-fertilized plots. In spite of the inevitably large experimental errors with field experiments, the agreement was surprisingly good.

Plotting the leaf analysis values of potassium against the surplus of yield after treatment with potassium fertilizers, we get a curve approximating a hyperbola. Similar curves were obtained in respect of the nitrogen content of the leaves and the effect of nitrogen fertilizers. Phosphoric acid also revealed the same principal rule, namely, an approximately inverse relation between the concentration of phosphorus in the leaves and the increase in yield after treatment of the soil with superphosphate. Moreover, the leaf analysis demonstrated the co-operation of the nutrient factors according to the principle of limiting factors.

An example of the interaction of potassium and phosphorus is illustrated by Fig. 3: if the soil suffers from phosphorus deficiency (= low P-value in the leaves), fertilization with potassium salt alone will yield less than if superphosphate were added. Similarly, leaf analysis enables us to decide whether superphosphate will pay without simultaneous nitrate fertilization or not.

The advantages of leaf analyses, compared with soil analysis, are summed up as follows: the plant will indicate more precisely the availability of the nutrient salts in the soil, because it has its own methods of extraction. Moreover, leaf analysis gives not only an instantaneous picture of the situation in the soil, but also sums up the extraction of salts during a period of several weeks, for the samples are taken at a stage when the vegetative parts of the plant are fully grown but still vigorous. This viewpoint is important, not only in respect of the availability of nitrogen, but also in respect of potassium, phosphoric acid and calcium, which components are extracted from the soil by the joint action of the roots and the soil micro-organisms.

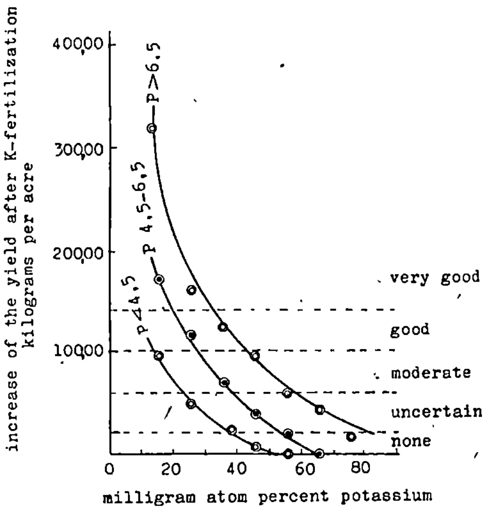

Fig. 3. PROBABLE EFFECT ON THE YIELD OF FERTILIZATION WITH 60 KGM. 40 PER CENT POTASSIUM SALT PER ACRE. A LOW CONTENT OF POTASSIUM IN THE LEAVES INDICATES GOOD RESULTS, HIGH CONTENTS LESS GOOD, ETC. INCREASING SUPPLY OF PHOSPHORUS RAISES THE UTILIZATION OF POTASSIUM.

A drawback connected with the method of leaf analysis is the variability of the environmental factors, especially rainfall and temperature. As the samples are taken at a comparatively early date, variations in the second part of the season have no influence. But a dry summer tends to raise the concentration of nutrient elements in the leaves, whereas a wet period influences the development in the opposite direction. The experience of the last five summers, with their large amplitude of temperature and rainfall, teaches that samples taken on the same plot reveal certain variations in respect of leaf analysis, but these variations are reasonably limited. The method of leaf analysis will thus probably be of some value in teaching the farmer how to economize with mineral fertilizers and how to use them in the right proportions.

[1] Lundegårdh, H., "Die Nährstoffaufnahme der Pflanze", Jena, 1932; *Ann. Agric. Coll. Sweden*, 9, 127 (1941).

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PLANNING POST-WAR BRITAIN*

THE Institution of Municipal and County Engineers has prepared a report in consequence of the Government's acceptance of the principle of planning on a national scale. The national plan should, it is suggested, be prepared on broad lines by a ministerial department which should lay down general principles for the whole of Great Britain. These should deal with policy, standards and national details, such as communications, zoning as affecting national parks, preservation of mountains, moorlands, recreational coastline, forestry, etc., and electricity, gas and water supply. Under policy would come such matters as enabling legislation, agricultural systems, distribution of industry and of population, while under standards would be considered minimum conditions of housing, industrial and commercial zoning and lay-out and recreational facilities.

Local authorities, it is suggested, should remain responsible for detailed planning, together with allied matters such as drainage, road-making, bridge-building and housing, but to secure co-ordination of detail over wider areas there should be a statutory obligation on local authorities within a particular region to collaborate in the preparation of a unified scheme. The boundaries of regional schemes should be defined by the central authority in consultation with local authorities. They should be fixed more with the view of community of interest and topographical considerations than of local government areas.

A major section of the report is then devoted to national and regional communications, and a Government investigation of the whole subject in all its bearings on the life of the community is recommended as a basis for planning. In regard to railways, it is recommended that any necessary financial or other assistance should be provided without restricting other forms of transport. More use of canals and water-ways for the transport of heavy goods is recommended to relieve congestion on railways and roads, but the major feature of this section is the recommendation regarding the provision of high-speed motor-ways—single-purpose roads restricted to motor vehicles—a proposal which was urged with great force by Lord Sempill in the House of Lords debate on November 19.

Dealing with the development of built-up areas as part of a complete town plan, the report insists that the planning authority for a district must decide the type of buildings on a site and lay down the standards for the widths of roads, heights of buildings, general style of architecture, housing density, etc. The complete plan of any town or the redevelopment of particular districts must keep in mind the provision of

* Post-war Planning and Reconstruction. Pp. 48. (London: Institution of Municipal and County Engineers, 1942.) 1s.

adequate communications and parking facilities, preservation of the historic character of the town, ancient monuments, well-known thoroughfares, etc., spaciousness in suitable districts combined with compactness of design on building sites, and grouping of civic buildings, shopping, museums and recreational facilities according to their character and demand. In regard to the establishment of satellite towns, the report suggests that the first step should be an analysis of residential requirements. This should include a survey of existing residential development and the extent of over-crowding, the consideration of types of residential development required and maximum densities, and a survey of reservations of land at present used for residential purposes, with the object of distributing the existing industrial or business development and providing the needed areas of open space, playing fields, etc.

On the establishment of new industries in existing towns the report urges that factors such as the more equitable distribution of the world's raw materials, the state of Great Britain's heavy industries due to increasing production in foreign countries and a policy of emigration to develop the resources of the Empire make the proper distribution of existing industries more important than the establishment of new ones. New industries should be located in suitable places throughout the country in or adjacent to existing towns which have suffered from depression, the environs and needs of which have been properly planned and considered beforehand. Care should be taken that agricultural life is not disturbed and that agriculture is given its rightful place as a vital industry, the rural surroundings of a town being regarded as a natural and essential complement to a well-balanced urban community. The suitability of light industries for the fringes of country towns once again receives recognition, while the serious monetary problems which the law at present offers in planning agricultural belts and parkways between existing towns and future growths is firmly emphasized in a plea for enactment of a bolder and more equitable policy. In particular, a planning authority should no longer be liable to compensate owners of agricultural land for the loss of potential development value which never existed.

Attention is then directed to problems of regional drainage, both of surface-water and of foul-water drainage, including the purification of sewage and trade waste. The boundaries of the regional authorities undertaking these matters should be dictated by geographical considerations and would not necessarily coincide with the boundaries set up for the purpose of unifying local government on a regional basis. Similarly, while it is recommended that the water policy of Great Britain should be guided nationally by a central authority, directly responsible to Parliament, with power to control and co-ordinate all water sources, the central authority's administrative powers should be devolved on regional bodies, also possessing statutory authority, and controlling areas related to the areas of the respective watersheds grouped with suitable districts. A comprehensive and accurate investigation of all water resources, whether above or below ground, the consolidation and modernization of water legislation, including the simplification of the control of rivers, and an overhaul of the present system of rating water undertakings are further recommendations.

In the section on desirable standards for buildings, buildings and light angles, the report has special weight. The Institution of Municipal and County Engineers has frequently had to protest to the building by-laws section of the Ministry of Health at recent weakening of the by-laws relating to building and the forcing of them on unwilling and protesting local authorities, which has resulted in a decrease in structural stability and health protection. Some of the Institution's contentions as to the small factor of safety have been confirmed by the recent disastrous effect of blast, hundreds of yards from single detonations, on the large breeze-block, lath-and-plaster type of building erected under new by-laws, as against the stability of habitations, close to the explosion, erected under old regulations. The report submits that the clauses in future issues of model by-laws should be the result of decisions taken by a representative committee of those affected by such by-laws, including adequate representation of the Institution, having regard to the responsibilities of its members for enforcing such by-laws.

The final section of the report details desirable standards for highways, parkways, services, recreation and industrial development with regard to the preservation of amenities. These are based on the assumptions that a high-speed motor-road policy will be adopted in Great Britain independent of existing highways, with a link to the Continent, and that a national plan will give guidance on the distribution of services. All questions of planning should be controlled by a minister of Cabinet rank. Among these specific proposals are the placing of all signs and advertisements under the control of planning committees with powers for securing the removal of all signs detrimental to amenity, the taxing of all advertising posters according to their size and the licensing of all advertising stations. Street lighting, the provision of adequate car parks and the enforcement of their use, control of woodlands and trees by the Forestry Commission after agreement with the planning authorities and the removal of noxious trades from the centres of towns to zones the siting of which is not necessarily restricted to the local Parliamentary boundaries, are other points which illustrate the way in which this admirable report indicates the action required to implement an effective policy of planning. The extent to which the recommendations endorse those of the Scott and the Uthwatt Reports is notable.

HEALTH SERVICES IN GREAT BRITAIN

DR. JOAN McMICHAEL, speaking on February 21 at a Conference on Health attended by trade union leaders and held at the Conway Hall, London, voiced the dissatisfaction of many trade union officials and workers in the health services of Great Britain at the great loss to the war effort from illness in industry. Apart from the great increase in the incidence of tuberculosis and venereal disease, much of this morbidity is due to colds, influenza and accidents; these were largely attributed to the influx into factories of persons unaccustomed to industrial conditions, and adversely affected by the long hours of shift work in factories. The black-out, the inadequate arrangements for married women, the shortage of doctors and nurses, and anxiety-states due to the War also contribute. To help reduce this loss of work she recommended the development in factories of Workers' Health Committees, as sub-committees of workers' committees or joint production committees. These new committees should act as workers' health and safety inspectors, should collaborate with medical men to conduct health education in factories, investigate the usefulness to workers of mental stimuli such as music and film shows, suggest arrangements for special cases such as antenatal examinations for pregnant workers, and co-operate with other health-promoting bodies in the district. She further suggested that the powers of local authorities under Section 8 of the Factory Act should be extended to cover cleanliness, ventilation, lighting, temperature and overcrowding; and that a State industrial medical service responsible to the Ministry of Health should be introduced, sharing and applying the results of research.

Dr. Mark Daniels, reviewing the state of the health services in the London boroughs, considered that many of the difficulties in health matters are due to inadequate use of the existing facilities. On the credit side, there had been no major epidemics, no fall in the level of nutrition of school children (except, significantly, in those entering school at age five), while communal feeding has been extended, and preferential treatment has been given by the Ministry of Food to heavy manual workers, expectant mothers and young children. On the debit side, there is the increase in tuberculosis, infantile mortality and deaths in childbirth, and a definite increase in diphtheria and venereal disease. Though the Ministries have made numbers of excellent recommendations, it is none too easy to get them carried out; the available arrangements are often not used to the full, owing to the inadequate education of the public in medical matters. He instanced the failure to make full use of facilities for immunization against diphtheria, for the treatment of venereal disease, and for the provision of cod liver oil and orange juice to expectant mothers. In his opinion, trade unions should lose no opportunity of raising health questions—should even devote whole conferences to health matters. To these conferences medical men should be invited so that they can get to know what the problems at hand really are. Trade unions could also assist in establishing the necessity for the provision of communal feeding centres, for shopping and transport facilities for workers, and for social and recreative facilities, especially for young persons. They could also help in petitioning for war-time nurseries and school canteens.

Sister Mary Morse contended that shortage of domestic staff aggravates the shortage of nurses, who are compelled to do non-nursing work. Nurses are overworked, and she said there is little doubt that the impossibility of giving proper attention to their patients, combined with delay in admitting sick persons to hospitals, greatly lengthens the period of illness. The shortage of nurses is due to the conditions under which nurses work in hospitals; she suggested that there is not much likelihood of improvement until nurses are organized, and the Essential Works Order and trade union machinery applied in hospitals. Though the Rushcliffe Report was a step in the right direction, the remuneration proposed for the very responsible ward sister is still inadequate, and domestic staff are not considered at all. The problem is urgent, as a 'second front' in Europe would make enormous demands on nurses. Moreover, she considered it scandalous that while there is so great a shortage of medical men the majority of the teaching hospitals in London still refuse women students.

An immediate step towards the solution of the nursing problem would be the formation of a joint consultative committee of nurses and other hospital staff, which would determine the best way in which the limited resources of the hospitals could combine for the improvement of hospital services.

Resolutions embodying the main suggestions of the two openers were passed unanimously by the Conference.

MEASUREMENT OF SHORT ELECTRIC WAVE-LENGTHS

AN article with a mathematical basis entitled "Wavelength Measurements of Decimetric, Centimetric and Millimetric Waves" by A. G. Clavier (*Elect. Comm.*, 20, No. 4; 1942) considers the measurement of waves shorter than one metre, and describes apparatus specially adapted to this purpose. The measurement of these wave-lengths presents peculiar difficulties and necessitates the construction of specialized apparatus.

In the region of decimetric waves, it is still possible to construct an oscillating circuit of lumped electrical constants. The selectivity of such a circuit can easily be estimated by means of its magnification factor, derivable from low-frequency technique.

Certain considerations presented in the paper and the necessity of finding an easy method of calibration in terms of wave-length have led to the use of circuits with distributed constants and, in particular, transmission lines. In the first instance, transmission lines made up of two parallel Lecher wires were considered in which the separation between the wires is small compared with the wave-length; radiation can be ignored as a first approximation and Kirchhoff's laws applied by assigning line constants R, L, C to the line. For very high frequencies, leakance between wires may also be ignored.

Transmission lines with parallel wires are especially suitable for decimetric wave-lengths; the resonance positions are repeated periodically along the line and their separation gives the wave-length to be measured. Such lines, with variations, have been used by numerous experimenters.

Lecher-wire wave-meters are in current use for the measurement of decimetric waves, but they have the following disadvantages. Line radiation increases with the frequency; it is difficult to localize the excitation at one point of the line; it is not easy to eliminate effects due to surrounding objects and movements of the operator. It is consequently preferable to use coaxial lines, and a wave-meter of this type was designed in 1931.

Coaxial-line wave-meters may be used for the measurement of wave-length up to the centimetre wave-band. For wave-lengths of a few centimetres, however, the influence of the transverse dimensions of the coaxial line causes trouble, and coupling problems arise making dielectric guides necessary. The simplest of these consist merely of a metallic pipe without an inside conductor, and electromagnetic waves may be propagated through them provided the wave-length in air is below a certain limit which is of the order of the diameter of the guide.

To measure wave-lengths with dielectric guides, it is necessary to transform the wave-lengths measured along the guide into the wave-length in air. In the present state of the art and with transmitted frequency stability available, it is possible to rely on the theoretical relationships established between these wave-lengths. It is advisable to work fairly closely to the cut-off wave-length, since in this region a relatively small variation in the frequency causes a considerable variation in the wave-length along the axis of the guide.

Measurements of wave-lengths of less than one centimetre have been made with equipment illustrated in the paper. The wave-length of a magnetron especially constructed for wave-lengths of this order required determination. The magnetron sent an H_1 wave into a guide of 0·5 cm. radius. A crystal detector was coupled to the guide and connected to a milliammeter. At the end of the guide a movable piston, which had very good high-frequency contacts with the wall of the guide, was displaced by a micrometer lead. Accuracy was increased by taking measurements at a certain number of half wave-lengths.

Other methods of measurement have been utilized. In particular, the quasioptical properties of these oscillations suggest the adaptation of interferometers and gratings. Thus, as might be expected, there is a tendency towards the technique of measurement used at the long end of the infra-red spectrum.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, March 13

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Council Chamber, Moreton-in-Marsh, Glos.), at 2 p.m.—Conference on "Reconstruction and Country Life" (Principal Speaker: Dr. C. S. Orwin).*

Monday, March 15

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 7.30 p.m.—Dr. K. Mendelssohn: "Low Temperature Research".*

Tuesday, March 16

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Harry Luke, K.C.M.G.: "The British Colonial Empire in the Pacific".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 3 p.m.—Sir Henry Dale, G.B.E., P.R.S.: "Chemistry in Modern Medicinal Treatment", (i) "Pre-scientific Discoveries".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in Room No. 7, The University, Manchester), at 5 p.m.—Mr. A. L. Armstrong: "The Excavation of Pit 15, Grimes Graves, Norfolk, 1939, and Discovery of a Figurine of the Mother Goddess, associated with evidence of Ritual Worship".

Wednesday, March 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. W. P. Hildred: "The Future of Air Transport".

INSTITUTE OF PHYSICS (JOINT MEETING WITH THE LONDON AND SOUTH-EASTERN COUNTIES' SECTION OF THE INSTITUTE OF CHEMISTRY) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Mr. E. D. Eyles: "High-Speed Kinematography".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.30 p.m.—Prof. Herbert Dingle: "Atoms, Molecules and Radiation" (G. J. Symons Memorial Lecture).

Thursday, March 18

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. H. Simpson: "Some Problems in Statistical Theory".

ASSOCIATION OF SCIENTIFIC WORKERS (IN CO-OPERATION WITH THE WOOLWICH AMENITIES COMMITTEE) (in the Council Chamber, Town Hall, Woolwich, London, S.E.18), at 7.15 p.m.—Sir Robert Watson-Watt, F.R.S.: "The Scientific and Technical Worker in the Public Service".

Friday, March 19

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Sir Alfred Egerton, F.R.S.: "Warmth and Comfort Indoors".

Saturday, March 20—Sunday, March 21

BRITISH ASSOCIATION (DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1).—Conference on "Science and the Citizen, the Public Understanding of Science".*

Saturday, March 20

10 a.m.—"The Exposition of Science".
(Chairman: Sir Henry Dale, G.B.E., P.R.S.).
2.15 p.m.—"Radio and the Cinema".
(Chairman: Sir Allan Powell).

Sunday, March 21

10 a.m.—"Science as a Humanity".
(Chairman: Prof. J. L. Myres).
2.15 p.m.—"Science and the Press".
(Chairman: Sir Richard Gregory, Bart., F.R.S.).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER TO TEACH PRINCIPALLY ENGINEERING WORKSHOP PRACTICE AND DRAWING, in the Junior Technical School of Whitwood Technical College—Mr. M. G. Swaine, 97 Smawthorne Lane, Castleford, Yorks. (March 20).

TEACHER OF MATHEMATICS, TECHNICAL DRAWING, AND ONE WORKSHOP SUBJECT, PREFERABLY WOODWORK OR JOINERY AND CARPENTRY, in the Dinnington-Chelmsford Junior Technical School—Mr. G. E. Nicholson, Orchard Chambers, Church Street, Sheffield 1 (March 20).

TEACHERS FOR (a) MECHANICAL ENGINEERING SUBJECTS, (b) MATHEMATICS AND PHYSICS, in the Smethwick Municipal College—The Chief Education Officer, Education Offices, 215 High Street, Smethwick 41 (March 22).

LECTURERS IN (a) MECHANICAL ENGINEERING, (b) ELECTRICAL ENGINEERING—The Registrar, Loughborough College, Loughborough, Leics. (March 22).

DEPUTY CHIEF ENGINEER AND MANAGER OF THE BIRMINGHAM ELECTRIC SUPPLY DEPARTMENT—The Chief Engineer and Manager, 14 Dale End, Birmingham (endorsed 'Deputy Chief Engineer and Manager') (March 30).

CHAIR OF CHEMISTRY in the University College of North Wales—The Bursar and Acting Registrar, University College of North Wales, Bangor (April 3).

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield.

LECTURER IN ENGLISH for British Institute, Leopoldville, Belgian Congo, to teach English to European adults and assist in Cultural Activities—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Leopoldville').

ASSISTANT WORKS MANAGER (OPTICAL) for new instrument factory, Indian Ordnance Services—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Ref. C.1500, Alexandra House, Kingsway, London, W.C.2.

LECTURERS (FULL-TIME OR PART-TIME) IN MECHANICAL AND ELECTRICAL ENGINEERING SUBJECTS—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Section D.565, Alexandra House, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Birmingham. Report of the Vice-Chancellor and Principal to the Council for the Forty-second Session 1941–1942. Pp. 20. (Birmingham: The University.) [291

Other Countries

New Zealand. Sixteenth Annual Report of the Department of Scientific and Industrial Research. Pp. 34. (Wellington: Government Printer.) 1*s*. [291

Smithsonian Institution. War Background Studies, No. 4: Peoples of the Philippines. By Herbert W. Krieger. (Publication 3694.) Pp. iv+86+24 plates. (Washington, D.C.: Smithsonian Institution.) [291

University of Florida Publication. Biological Science Series, Vol. 3, No. 2: The Crayfishes of Florida. By Horton H. Hobbs, Jr. Pp. v+179+24 plates. 2.25 dollars. Biological Science Series, Vol. 4, No. 1: The Plant Communities of the Welaka Area, with Special Reference to Correlations between Soils and Vegetational Succession. By Albert Middleton Laessle. Pp. 143 (14 plates). 1.50 dollars. (Gainesville, Fla.: University of Florida.) [291

Smithsonian Miscellaneous Collections. Vol. 103, No. 6: On the Preparation and Preservation of Insects, with particular reference to Coleoptera. By J. Manson Valentine. (Publication 3696.) Pp. ii+16. (Washington, D.C.: Smithsonian Institution.) [291

NATURE

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COLONIAL DEVELOPMENT IN THE BRITISH EMPIRE

THE development of British Colonial territories is not least among the problems which are already laying claim to the funds of human energy and economic material resources which will be at our disposal during the reconstruction period. An increasingly keen discussion of Colonial policy, both in Parliamentary and in unofficial circles, has accompanied the recent steps taken by the Government to provide funds and expert personnel to assess the full import of the issues, to estimate the scale of essential needs and to embark without delay on actual projects. The publication of Sir Frank Stockdale's first report of progress in the West Indies is an earnest for the future.

With the Colonial Development and Welfare Act of 1940, the Government has embarked on a long-term scheme of advance in the Colonial territories, with the improvement of standards of living of their peoples through the active development of natural resources as the keynote of policy. The older principle whereby development was confined within the limits of the internal finances of each territory has been abandoned in recognition of the fact that in many cases they "cannot, however efficient their economic administration, finance out of their own resources the research and survey work, the schemes of major capital enterprise, and the expansion of administrative and technical staffs which are necessary for their full and vigorous development" ("Statement of Policy on Colonial Development and Welfare." Cmd. 6195 ; 1940). This is a sphere in which the scientific world—and particularly those concerned with biological and sociological aspects—can do much to further the declared policy. Both the considered views of men of science at home who can contribute to the framing of policy, and the more direct services of those who will enter the field of Colonial development, will be needed. Hence the importance of the widest appreciation of the social and technical problems involved, and the need for consideration of the ways in which as individuals and through their own institutions men of science can most effectively contribute to wise planning and orderly development.

In the very full debates in the House of Lords during the past year, two particular issues have come to the fore. First is the need for mustering and putting at the service of the British and the Colonial Governments the advice of those who can contribute from their experience and special knowledge. Lord Trenchard has advocated the establishment of a Colonial Board or Council. Originally it seemed that he wished such a body to be comprehensive in its terms of reference and empowered to report regularly and directly to Parliament. The difficulties that might be expected to follow from the existence of two largely separate sources of direction on Colonial policy, the Colonial Office itself and an Advisory Council reporting independently, were emphasized by Lord Cranborne as Secretary of State, but the Government has shown no aversion to the further development of advisory bodies responsible to the Colonial Office itself.'

The most fruitful and expeditious direction of advance would indeed appear to be along these lines, and the limitation of a council to the economic field, which Lord Trenchard—apparently by way of concession—suggested in his more recent speech, does not seem to be necessary or desirable. A number of advisory committees have in fact already been set up by the Colonial Office. On them sit experts, members of Parliament and men with long Colonial experience, and they already cover such fields as education, agriculture, labour and welfare. To their number has recently been added the Colonial Research Advisory Committee under the chairmanship of Lord Hailey, which will advise on the further development and organization of scientific research which the Colonial Development Fund has made possible. The next steps would therefore appear to be the completion of the series of advisory committees required to cover the whole field of Colonial problems, including economic policy and administration and, equally important, their integration by means of a central advisory body. With representatives from the component committees sitting together, such a Central Council, itself fully informed of the questions on which its several committees were working, the problems of balanced development, both between and within particular territories and fields of development, would on the advisory side be in the road to solution. At the same time, the parliamentary and other representation on the committees and Council should ensure both the public insight into Colonial problems and the close touch with government policy which Lord Trenchard and others are so anxious to secure. It would also go far to foster public interest and concern in the future of the Colonies without raising a question of constitutional innovation, the discussion of the merits of which might well distract attention from immediate needs and opportunities.

On such a Central Council, as on the existing advisory committee, scientific workers would have an important constructive part to play and an opportunity to pool experience with their colleagues from the administrative and commercial spheres in seeking the most effective means of carrying out the dual mandate—securing both the welfare of the Colonial peoples and benefits for their Western partners.

The second major question concerns recruitment and training for all branches of the Colonial Service. During this War there has been a closer concern than in 1914–18 for provision for the future, and the need for hurried reinforcement of depleted Colonial staffs may not be so acute; but the fact that development on all fronts is being planned for the Colonial territories will mean that an increased and a more varied personnel and, hence, a considered plan of post-war recruitment and training, will be required.

The Secretary of State, in response to suggestions that the source of recruitment should be widened, has pointed out that the Selection Board for the Colonial Service is not tied to a narrow range of either age or scholastic attainment and itself includes a non-official member. Here, too, the value of scientific training may need affirmation. The maintenance of scientific standards in appointments to the technical services is only part of the question. There remains the need for securing an increasing receptivity and understanding among administrative officials towards the scientific approach which must lie behind so much of the work of those departments. On the other hand, the scientifically trained staffs of the technical departments have to apply their knowledge in a social context not only very different from that of Great Britain itself, but indeed one in which much may depend on their appreciation of the outlooks of the peoples they work among and of their administrative colleagues who are directly responsible for orderly social development.

In the recent suggestions for the establishment of a Colonial Staff College great emphasis has been laid on the need for affording Colonial officials not merely the technical knowledge for their particular spheres, but also an understanding of all the related fields of Colonial development and of the wider economic and other social problems of the world as a whole. The desirability for the greatest community of ideas between the administrative and the scientific staffs of Colonial areas is obvious. There is need for thought on the best ways of making plain the nature and importance of scientific contributions to those whose earlier training and experience may have provided little foundations for such understanding. This in turn raises the question whether a closed service institution would in fact provide the best training ground for those in whom the widest outlook is desired, a point that will become increasingly important as personnel are drawn more and more from the Colonial territories themselves, and the assimilation of Western standards will be part and parcel of training in all fields.

Moreover, the Colonial Services differ from a military or purely administrative system precisely in the very wide range of their activities, which comprise not only administrative and political, but also a number of educational, technical and scientific fields. The training of technicians and scientific workers for a particular service is most economically and comprehensively achieved in institutions where the field of knowledge rather than the particular post is the basis of organization. There is much to be said for this point of view with regard to the training of political officers.

For the existing practice, whereby advantage is taken of facilities in the universities in training for the Colonial Service, considerable success can be claimed, particularly with respect to the generally admitted need for guarding against an excessive insularity of outlook among Colonial officials, many of whom spend long years in remote areas and in very special circumstances. Facilities associated with the universities could without difficulty be extended and where necessary further specialized, and they provide a particularly suitable environment for the frequently advocated supplementary courses which should be taken by men after a number of years of service. The Colonial Service would in this way be able to continue to share in the benefits of that universal framework for more specialized studies which the universities seek to confer. There should, in view of their traditions of freedom and of devolution of authority, be no serious difficulty in developing, in one or more of the universities of the British Empire, in close association with academic departments including special Colonial studies, training schools which, while providing fully the conditions needed for the desired *esprit de corps*, would have the advantages of a continuous outlook on wider horizons.

THE PUBLIC LIBRARY IN RECONSTRUCTION

THE importance of the industrial or scientific library as a tool of research and as a service to the investigator or technical man on a par with the material services such as power supply, light and water, which along with his equipment he is apt to take for granted, is now gaining recognition. This interest must now be extended to include the public library service, for an efficient public library service is highly important as a factor in adult education. The public library service, too, must play an important part in education for citizenship, and in that respect scientific workers themselves might well be glad to avail themselves more freely of its services.

These reasons alone would give public library services an important place in reconstruction. The report on "The Public Library System of Great Britain", prepared by Mr. L. R. McColvin, city librarian of Westminster, for the Library Association, demonstrates beyond dispute the need for drastic overhaul and reorganization. This report, however, has also a close bearing on those questions of regionalism and the relation between national and local control which are encountered almost everywhere when plans for post-war development are being considered. The provision of public library services has hitherto been left entirely to the local authorities, and the quality of their performance affords a fair test of their fitness for full responsibility in others.

The Acts of Parliament by virtue of which public libraries exist are permissive, not compulsory. That does not invalidate the fairness of this test of the fitness of the local authorities, but this survey, with its picture of widely varying performance, leaves an outstanding impression of the unsatisfactory general provision and of a badly organized service which reflects sadly on the competence of the local authorities and stamps permissive legislation in this field as a comparative failure. That is indeed the major interest of the survey itself. On points of detail the scientific worker will note the duplications, deficiencies and glaring disparities which abound, the absence of general standards for salaries and the consequence that many library workers are not properly qualified for their posts, understaffing and inadequate premises, parsimonious expenditure on books and indeed every other item, and the pronouncement that reference library work is the outstanding failure of librarianship in Great Britain.

One point in this survey has direct implications for the scientific worker. Mr. McColvin emphasizes the fact that a poor library does not immediately result in a demand for a better one. The public does not normally ask for a better library service unless it already has experience of a good one. It is only a good library that can demonstrate the advantages and uses of a developed service. Mr. McColvin, in fact, points out that several counties and backward municipalities have been, if not compelled to improve, at least made cognizant of their deficiencies, by evacuated readers who have been accustomed to good libraries in their home towns. Similarly, scientific workers who have at least learnt something of the value and possibilities of a library service owe it to their fellow citizens to play their part in securing for the community as a whole a public library service which adequately meets the purposes set forth in this report.

The basic purpose of the public library, in Mr. McColvin's view, is the utilization of the recorded experience and thought of the men and women of yesterday and to-day to help in the making of citizens better able to contribute to, and benefit from, the constructive life of the community, the nation and the world. Much of that accumulated experience is only available in books, and the society which lacks adequate public libraries is accordingly handicapped by the lack of information and knowledge essential to its material, mental and spiritual development. Books, he urges, are essential to any real democratic conditions of living; they are the tools and the symbols of true freedom.

That conception of an efficient, readily accessible and comprehensive library service, hospitable to all phases of thought, as an essential element in a progressive society, will be endorsed everywhere. The execution of the broad programme outlined in this report and the details of its proposals will rightly be held largely a matter for discussion and decision by the professional librarian in the first place, though even at this stage the scientific worker might well support some of the proposals or observations, such as the adoption of a deliberate national policy of linking up and strengthening existing special libraries, so reducing unnecessary duplication, and gradually extending their range. Moreover, some at least of its observations in regard to stock, purchases, premises and methods are as relevant to the specialist or departmental library as to the general or public library, and well deserve to be carefully weighed.

Mr. McColvin's proposals, however, are worth noting for the further reason which is evident even from a brief summary. An efficient library service may well be an important factor in reconstruction; but, in addition, library reform is an excellent example of the technique required in a democracy for the adjustment of its institutions by consent to serve the purposes of an ever-changing society.

The faults of the present system, on Mr. McColvin's showing, are attributable to the inherent defects of local control. The first task is therefore to create, as the area for each independent local library service, a local unit sufficiently large to facilitate co-ordination and ensure efficiency and economy. These units, of which ninety-two are enumerated, will comprise areas formed for geographical reasons and answering to the distribution of population. Each unit would include an administrative and distributive headquarters with main central library and a radiating system of libraries, branches, distributing centres and travelling library vans, appropriate to the different aggregations of population in the area, the urban and rural services being under a single direction.

Mr. McColvin insists on the management of the unit remaining in local hands and not being placed under the control of the central government or of larger regional authorities. On the other hand, he is emphatic as to the necessity of a central national department responsible for guiding, co-ordinating and encouraging library development, making grants in aid of library services, and supervising their expenditure. He also urges the development of large regional reference libraries assisted by national funds, as well as the fullest possible co-operation between public libraries and all types of other libraries and institutions for research, especially in connexion with specialization and inter-library lending. Efficient management, staffing and an appropriate relation between supply and demand are other points in the proposals.

The National Central Library should be an integral part of the national system and guaranteed a reasonably permanent means of existence and the resources to plan for the future and for whatever developments the national interests might demand. Primarily, it would be a clearing house and centre for the execution of national library projects—cataloguing, bibliography and co-operation. With the development of good library units throughout Great Britain, it should no longer be necessary for the National Central Library to act as a storehouse of reserve stocks, and the units should also decrease the demands on it for work for adult education. Moreover, the removal of the limitations imposed by financial stringency on its present or contemplated work, the supply to library units of specialized books which it is impossible or undesirable for the units to provide themselves, the maintenance of the necessary organization for such inter-lending, the development and maintenance of co-operation between public libraries and others, including the special libraries, its functions as a national centre for bibliographical information, as a central cataloguing department, in organizing international loans and as a centre and clearing house for bibliographical information regarding the literature of other countries, would enable the National Central Library to form the natural keystone of all inter-library co-operation.

With regard to the central authority, Mr. McColvin suggests either a department of a new Ministry of Arts or a Libraries Department of the Board of Education, though he directs attention to the danger of associating a library system too closely with education in the scholastic sense. In addition to the broad duties already indicated, this authority would also be responsible for formulating minimum standards of library service, especially in regard to the supply of books, the availability of services and the qualifications and salaries of those engaged in library work, as well as for the collection of information, conduct of inquiries or issue of reports on the general progress of librarianship and on special aspects thereof. The proposals contemplate an interim period of voluntary reorganization, and the application of compulsion only as a last resource.

It is clear that these proposals touch fundamental issues involved in regionalism and in the re-grouping of local government units. Mr. McColvin recognizes that the civil defence regions of Great Britain may not prove altogether suitable regional units, and that new areas introduced as a result of changes in local government may equally be unsatisfactory and unsuitable for library purposes. He also recognizes that, on the other hand, there may be no considerable reform of local government areas in general for some years. None the less, he urges librarians to place their ideas and ideals at the disposal of all who are concerned with the reconstruction of local government, and to collaborate with them to the fullest possible extent.

In thus urging collaboration and readiness to accept adjustments of the unit system where the adjustments are not such as to prejudice seriously the essential requirements, Mr. McColvin shows the same wisdom and restraint which throughout his report balance his stout defence of the independence and identity of the librarian. It cannot be said of this report, as of some other recent ventures into the field of reconstruction, that the proposals are more concerned to advance the interests of a section than to serve those of the whole community. The fundamental truth that democracy is based on the consent of the governed is firmly upheld throughout.

The report is in fact to be welcomed for its support of those two points, apart altogether from the proposals it advances for reform in a matter which touches closely the mental well-being of the whole nation. It is a stimulus to constructive thinking about some of the issues upon which the existence of our democratic institutions depends. In recognizing the failure of small units, in library service as elsewhere, to function efficiently or even effectively, we should not forget that not only may those units have other contributions to offer, but also that it is of the essence of a democracy that their willing consent should be won to participation in the larger units now necessary. Secondly, it should be recognized, as is implicit in this report, that while it is for the expert and professional worker to submit his proposals, and even to execute them when approved, it is for the community to decide on policy.

There is no graver danger to reconstruction than the tendency to be observed in so many reports from the industrial and business world for sections to attempt to dictate policy and for their plea for self-government or freedom from interference to cloak an attempt to impose an economic system on the community in preservation of sectional interests. Democratic policy, it is true, must be positive, but danger lies in the plea that such questions as the abolition of unemployment, disease and ignorance should be regarded as technical questions and outside politics. In a parliamentary democracy, it is for the electorate to decide whether it is prepared or not to accept whatever restraints on individualism may be necessary to secure these or other objectives. It is then and then only for the expert to frame and execute, under the supervision of parliament, the measures necessary to give effect to the policy adopted by the electorate. Library service may well seem a small matter among the many problems which are the subject of debate for reconstruction to-day, but in this report 'first things' are laid bare with unhesitating precision.

BIOLOGICAL STATISTICS

The Reproductive Capacity of Plants

Studies in Quantitative Biology. By Prof. E. J. Salisbury. Pp. xi+244+7 plates. (London: G. Bell and Sons, Ltd., 1942.) 30*s*. net.

THOSE who are familiar with Prof. Salisbury's earlier applications of statistical methods to structural characters, presumed adaptive, will approach with lively anticipation this quantitative study of reproductive capacity. In his investigation of stomatal distribution he gave precision to the general observations of Zalenski and others, in particular that in dry conditions leaves tend to have more stomata per unit area, whereas the reverse might have been expected. He further demonstrated that, for a given species, the spacing of the stomata is dependent on the size of the epidermal cells and so on the degree of expansion of the leaf during its development. He thus contributed weightily to the replacement of the teleological by the causal point of view in the interpretation of such features.

In the present volume he has collected together measurements, accumulated over a period of fifteen years, of the number of fruits and seeds produced by sample populations of a wide range of species of representative habitats, with the object of examining quantitatively the rough impressions and certain teleological assumptions that have gained currency. The amount of labour and patience required in obtaining so impressive a body of data prompts the thought, *à chacun son métier*.

Among the leading questions propounded is whether the relative abundance and frequency of different species are correlated with their reproductive potentialities. On the other hand, since on the average the number of individuals of different species remains approximately stable, it has been commonly assumed that natural selection has brought about a nice adjustment between seed output and mortality: Is reproductive potentiality in fact proportioned to vulnerability, or is the production of a large progeny rather to be regarded as merely wasteful?

The complexity of the problems is made apparent from the outset. The author points out, for example, that fluctuation in number of offspring has the effect of countering the danger from predators. Though "mast" years lead ultimately to an increase in number of predators, the inevitable lag enables the sudden abundance to be effective in increasing the number of individuals, at least temporarily, and possibly securing the spread of the species. Another complicating factor is seed size, which is examined and discussed in Chapter 2. It is established that the more advanced the phase of ecological succession the larger are the seeds, on the average, of the species characterizing the vegetation; and the author points out that the smallest seeds are to be found among plants of open habitats, and also among parasites, saprophytes and mycorrhizal plants, which are not dependent for survival on early photosynthesis.

In Chapter 3 it is shown that parental vigour, estimated by the number of fruits borne, has no significant effect on the viability of the seeds set and very little on their size. Apparently, below a certain minimum of food supply an ovule or seed aborts and the effect of starvation is seen in fewer seeds of nearly normal size.

Having defined his terms, of which the most important is reproductive capacity, the product of the average seed output per plant and the average percentage germination, the author proceeds to examine the data for different edaphic and climatic conditions and the effects of competition. He remarks that competition may sometimes be the more important and gives examples of perennials in which the onset of reproduction is delayed for years by competition. Between individuals of the same species, on the other hand, while competition leads to depauperate individuals, it affects the total output but little whether many small or few large plants survive. In Chapter 7 it is established that no correlation exists between number of capsules per plant and number of seeds per capsule.

The remainder of the book is devoted to a comparative study of reproductive capacity over a wide range of examples. The general conclusion frequently emerges that there is no evidence of reproductive capacity being correlated with risk of mortality, but definite evidence of correlation with extent of geographical range (for example, Scilla spp.) and with relative abundance (for example, Hypericum spp., Gentianaceæ). Vegetative spread and multiplication complicate comparisons and receive special discussion in the concluding chapter.

The discussions of special cases are full of interest and are informed throughout with original observations which add greatly to the value of the book. It will provide a mine of information for contributors to the biological Flora, which is being compiled under the auspices of the British Ecological Society.

To the general reader it may be a matter of regret that the statistical data are given *in extenso* throughout the text. The summaries and, still more, the many comments and original observations are in consequence more difficult to pick out. While it is desirable that data so laborious of collection should be permanently preserved and accessible, the value of the book would, in the reviewer's opinion, have been increased had the bulk of the data been segregated. A limited number of examples would have sufficed to illustrate the chief statistical features and the methods of statistical treatment. The results could then have been given in the text mainly in the form of averages with standard deviations.

A minor point to which attention should perhaps be directed is the author's interpretation of probable error when, having obtained an average $A \pm p$, where p is the probable error of the mean, he states that the average would thus be between $A + p$ and $A - p$. The circumlocution adds nothing and might mislead, for the evidence does not suffice to tell on which side of A the mean of an indefinitely large sample would lie, or how far from A. D. T.

QUANTUM STATISTICS, CHEMICAL EQUILIBRIA, AND REACTION KINETICS

Equilibrium and Kinetics of Gas Reactions

An Introduction to the Quantum-Statistical Treatment of Chemical Processes. By Robert N. Pease. Pp. ix+236. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1942.) 22*s.* 6*d.* net.

THE correspondence between the equations of classical statistical mechanics and thermodynamics has been realized for a long time, having been demonstrated by the work of Boltzmann and Gibbs. Nernst and Planck afterwards introduced the concept of absolute entropy, with the statistical implication that the number of alternative states of a system is limited, indicating the necessity of applying quantum restrictions. The introduction of the atomic structure of matter into thermodynamics via statistical mechanics then made possible the calculation of absolute thermodynamic functions, and hence the evaluation of chemical equilibrium constants.

Dr. R. N. Pease has given a clear account of these developments in Part I of his book. The treatment is not absolutely rigorous, but it is doubtful if this can be considered a fault in a book designed as an introduction to the methods of quantum statistics for the student who is not primarily a mathematician, or for "the reader who has been separated from academic work for a number of years, and now wishes to catch up on recent developments in this important field of the interpretation of chemical processes". As would be expected, the selection and critical discussion of experimental material are admirable throughout.

Chapter 1 is largely a summary of elementary thermodynamics after the manner of Lewis and Randall, but contains also a section on the experimental determination of equilibrium constants. Then follows a consideration of the Nernst Heat Theorem, with the method of estimating entropies from specific heat measurements. A number of examples are given of the calculation of equilibrium constants from thermal data. Quantum statistical methods are introduced in Chapter 3, which explains the calculation of absolute entropies, free energies and equilibrium constants from spectroscopic data. This treatment largely utilizes the elegant methods of Giauque. The present position is set out clearly. For simple molecules, partition functions may be calculated precisely, and equilibrium constants derived from them are reliable. In the case of more complex molecules, there is often doubt as to the assignment of normal modes of motion, internal rotations, etc., and the partition functions and equilibrium constants are more likely to be in error. At present the problem of partially restricted rotation limits the usefulness of the statistical method. The normal procedure is the estimation of potential barriers in the molecule by a comparison of the entropy calculated by statistical methods with the thermal entropy, whereas what is really required is to be able to set up theoretical models in terms of which the spectroscopic data may be confidently interpreted.

The second part of the book deals with the kinetics of gas reactions. The application of thermodynamics and statistical mechanics to rate processes has proved a much more difficult problem, and the results are less certain. Modern theories suffer from the disadvantage of having to postulate an underlying equilibrium—between reactants and activated complexes in the case of chemical reactions—which is clearly only an approximation. The activated complex theory of reaction-rate, together with the older collision theory, are discussed at the beginning of the second part of Dr. Pease's book. The former is treated essentially by Eyring's method. There follows an account of what the author calls the four "classical" reactions—decomposition of nitrogen pentoxide, formation of hydrogen iodide, reaction between nitric oxide and oxygen, and formation of hydrogen bromide. In each case, with perhaps the exception of the third, calculations based on a simplified version of Eyring's theory lead to results which are in approximate agreement with experimental data. The author rightly points out that the number of reactions amenable to theoretical treatment in this way is small, either on account of inadequate investigation or uncertainty of interpretation.

Chapter 6 deals with quasi unimolecular reactions, and gives a review of the familiar Lindemann-Hinshelwood theory in the light of experimental data. It is difficult to disagree with the author's conclusion that it is doubtful whether any unambiguous experimental evidence for the validity of the theory has been obtained, except perhaps in the case of the isomerization of cyclopropane.

Chain reactions form the subject of the next two chapters (7 and 8). The main characteristics of these processes are illustrated by reference to a number of well-known reactions, including the hydrogen – chlorine reaction, the thermal decomposition of acetaldehyde (discussed at some length), and the thermal decomposition of ethers. Oxidation reactions, involving branching chains, are also treated.

The book concludes with a chapter on surface reactions in which the usual topics are clearly discussed; in addition, there is an interesting section on the extension of the activated complex theory to surface catalysis due to Laidler, Glasstone and Eyring.

Dr. Pease is to be congratulated on writing a very good book, which includes critical reviews of many different subjects in a comparatively small space, and which should be of great value to teachers and specialists in other branches of chemistry. The experimental side is well to the fore throughout; chemical reactions are generally very complex affairs, and the author has avoided a common tendency to simplify them. He has also abstained from building up complex theories on flimsy experimental bases. Indeed, one of the many pleasing features of the book is that the reader is left with the impression that it is often almost as difficult to measure the rate of a reaction as to calculate it.

C. H. BAMFORD.

FOOD AND PREGNANCY

THE average human baby weighs between 7 lb. and 8 lb. at birth; it contains about 370 gm. of protein, 25 gm. of calcium, 14 gm. of phosphorus and 0·4 gm. of iron. It builds up two thirds or more of these materials during the last three months before birth. All this material must come from the mother. Two questions arise. First, how is the transfer of the necessary material to the fœtus regulated? Secondly, how far does the health of the baby and mother depend on the mother's supply of food? These two questions occupied the English Group of the Nutrition Society at its meeting on February 6.

Food passes from the circulation of the mother to that of the fœtus through the placenta. This passage is not a free diffusion. Sir Joseph Barcroft discussed the placenta as a barrier. New information has been obtained by the use of heavy sodium. The guinea pig fœtus comes within 10 per cent of equilibrium with heavy sodium in the maternal plasma in 5–7 hours; the extracellular fluid of the mother comes within 10 per cent of equilibrium in about 5 minutes. It is possible to calculate the diffusion coefficient of oxygen across the placenta. About 0·1 ml. of oxygen passes from the blood of a ewe to her fœtus per square centimetre per second, when the difference between the pressure of oxygen in the blood of mother and fœtus is 1 mm. of mercury. Across other body barriers the diffusion coefficient is about fifty times as great. As the time of birth approaches, it becomes difficult to keep up a passage of oxygen through the placenta rapid enough to meet the needs of the fœtus.

The placenta may exercise a selective effect. According to Dr. Hoch, who spoke after Sir Joseph, the concentration of vitamin A in the plasma of mother and baby, at birth, is about equal; but the concentration of carotene is much higher in the mother's plasma.

The degree of obstruction by the placenta is reduced by mechanical means. Corrugation increases the area of the surface of interchange and the vessels of the fœtal and maternal circulation run in opposite directions. The hæmoglobin of the fœtus has a higher affinity for oxygen at low tension than has that of the mother. The hydrogen ion concentration of the blood of a pregnant ewe is raised; in consequence, the hæmoglobin of her blood gives up oxygen at abnormally high tensions.

The relative growth-rate of a goat fœtus, at different periods of pregnancy, is related to the rate of transfer of heavy sodium per unit weight of fœtus through the placenta. Hence, the rate of growth of the fœtus may be determined by the rate of passage of food through the placenta, and therefore by the size and vascularity of the placenta.

Dr. John Hammond suggested that the partition of food between fœtus and mother is regulated by the same factors as regulate the partition between different maternal tissues; that is, the fœtus, with a very high metabolic rate, competes with maternal tissues at a level slightly below that of the mother's central nervous system. The rate of growth is limited in some way by the mother. A foal, born of a Shetland pony mare inseminated from a Shire stallion, is smaller at birth and remains small until weaned. It is only when it eats according to appetite that genetic factors cause it to grow faster. The rate of growth, *in utero*, may be determined either by the rate of supply of food through the placenta, as suggested by Barcroft, or by the supply of an internal secretion or a metabolic substance produced by the mother.

The relation of growth to the supply of food to the fœtus becomes important in human pregnancy. The baby of a diabetic mother is fat, owing to the large amount of sugar supplied to it. Mr. Aleck Bourne, discussing fœtal development, stated that a large proportion of deaths *in utero* are due to smallness or ill-development of the placenta, and suggested that lack of vigour after birth may be due to undernutrition of the fœtus before birth.

How much, then, do the health of mother and offspring depend on the food supply of the mother? Lambs may be lost through neglect of the feeding of ewes in the late stages of pregnancy. But species differ, and the human mother is sacrificed to a much greater degree to the welfare of her offspring. Prof. A. St.G. Huggett said that he recognized five degrees of undernutrition of the mother; only in the most severe is the health of the baby affected. At one time the occurrence of fœtal rickets was disputed; however, it is found associated with osteomalacia of the mother, and the fœtus may suffer from keratomalacia if the supply of vitamin A to the mother is grossly inadequate. In the more severe degrees of under-nutrition, it may need four years of supplementary feeding to bring the baby back to normal, or it may never catch up completely.

Such catastrophes are seen only in extreme cases, but it might be expected that the health of the mother would suffer as the result of less severe degrees of undernutrition, even if the baby escapes. Apart from supplying the materials used by the fœtus, she has to provide some 300 gm. of protein for the development of the uterus and other reproductive apparatus; if the protein is not provided by her food, over and above her normal needs, it must come from other tissues. Pregnant women are known to suffer more than others when food is short. They may get osteomalacia, owing to lack of calcium and vitamin D; frank night blindness occurs during pregnancy in Newfoundland, for example, and clears up afterwards; in a large proportion of cases of beriberi in women the disease appears to have been brought on by pregnancy. We have laboratory evidence which appears to show that deficiencies of vitamins A, B, and C are more common among pregnant women eating their customary diets than among other women. For example, Dr. Hoch reported that he has found the levels of vitamin A in the plasma of pregnant women to be unusually low.

We come back to the old question of the intermediate states of deficiency. As Szent-Györgi has put it: How do we know that they are healthy, just because they have no scurvy? McCance and his colleagues collected records of the diets of pregnant women. The standard was so low, on the whole, and deteriorated so strikingly with fall of income, that it might be expected that there would be plenty of evidence of the ill-effects of undernutrition among poorer mothers. Mr. R. M. Titmuss, who discussed the relation of stillbirth and neonatal mortality to various influences, quoted the report of the Registrar General; the death-rate of babies, in the first month after birth, ranges from 22 per 1,000 in Class I to 33 in Class V. However, he showed that this issue is confused by many factors; for example, the degree of antenatal care, and the age of the mother, which is lower, on the average, in the poorer classes.

The frequency of stillbirth in England and Wales has remained practically unchanged since 1927, and mortality in the first month fell by only one quarter during the period from 1906–10 to 1937; whereas the mortality during the remaining eleven months of the first year of life fell by more than 60 per cent during the same period. Dr. I. Leitch, who followed Mr. Titmuss, suggested that, again, the results are complicated by improvement in antenatal care; more subnormal babies now survive to be born subnormal and die during the first month. The final value of any factor can only be assessed from the final results of the whole course of pregnancy and the early months of the baby's life. So many factors are involved that records of the distribution of deaths associated with pregnancy according to class, locality or time are not likely to give clear evidence of the effects of the single factor, nutrition.

There has been much unsound generalization about the effects of diet on the health of the mother. One may quote the instance of ketosis of ewes, which has been ascribed to overfeeding and lack of exercise. Here it was possible to make a clean experiment and Fraser, at the Rowett Institute, showed that ketosis did not occur in overfed sheep, but could be produced by underfeeding and cured by giving more food. Many still ascribe the rarity of eclampsia in Germany during the War of 1914–18 to the reduction of the amount of meat eaten. But the incidence of eclampsia rose immediately after the War ended, while the consumption of meat remained low. It would be more justifiable to give the credit for the reduction to the increased consumption of vitamin B_1, due to the higher extraction of grain during the war years. But it is now claimed that the changes were due to the fall in the number of first pregnancies during the war years. Eclampsia occurs more often in first than in later pregnancies.

There is one clear-cut instance of a deterioration of health of mother and infant due to deficiency of a nutrient in the ordinary diet. This nutrient is iron. In this instance, we have the specific evidence of iron deficiency, anæmia, and the unmistakable improvement when iron is administered. Mr. Aleck Bourne and Prof. Huggett both quoted three recent experimental studies of the effect of improvements of diet in other respects on the health of mother and baby: the Birthday Trust, the People's League of Health and the Toronto experiments. In these experiments the amount and quality of the foods supplied differed widely. In the Birthday Trust experiment, which was reported at this meeting by Lady Balfour, the extra food provided about 7 gm. animal protein, 0·35 gm. calcium, 0·3 gm. iron and, to those who were given yeast or Marmite, some 240 I.U. vitamin B_1. McCance and his colleagues measured the diets of twenty-five of the women who were receiving this extra food; the average amounts eaten per day were 36 gm. animal protein, 0·59 gm. calcium and 11·0 mgm. iron; it appears that the women either did not themselves eat all the extra food allowed to them or ate less of other foods, such as meat, when they were given this extra food. In the People's League of Health experiment the basic diets were probably better; large amounts of iron and moderate amounts of calcium and vitamin B_1 were given and the intake of vitamins A, D and ascorbic acid was raised well above the average. As these supplements appeared in the form of a 'medicine', they were in all probability consumed entirely by the recipient and not distributed among the family. In the Toronto experiment the diet was raised to a satisfactory level in every particular. In the Birthday Trust experiment, as reported by Lady Balfour, the frequency of stillbirths and deaths during the first month of the baby's life was reduced. In the People's League of Health the incidence of toxæmia (precisely defined) and of premature birth were lower in the supplemented than in the control group. In the Toronto experiment the number of subjects was small and the study more detailed; the chief significance of this experiment lies in the improvement of the subjects, as assessed clinically by an observer who did not know which of the subjects received the food supplements, and in the increase in the number who remained free from any complications. Also, the frequency of anæmia, toxæmia, threatened miscarriage, actual miscarriage, premature birth, endometritis, mastitis and breast abscess was less in the supplemented group, and the average duration of labour shorter; but as the numbers were small, the reduction in the frequency of any of these accidents may not be significant.

These three studies illustrate the difficulties that arise in this type of experiment. In the People's League of Health experiment the incidence of toxæmia was considerably higher in first than in later pregnancies. In the Birthday Trust experiment first pregnancies were more common in the control than in the supplemented group. In fact, Lady Balfour's report was largely devoted to the disentanglement of the confusing factors which might vitiate the results. When attention is focused on accidents, which occur in a small proportion only of the subjects, the results are not significant unless large numbers are studied; when large numbers are studied, it is difficult to control the diet and other interfering factors; and these accidents are, probably, not directly due to inadequacy of the diet. It would be better if it were possible to measure some feature that is present in all cases. Mr. Bourne suggested one; he said that obstetricians want to see 'vigorous' babies, and gave the ability to recover birth weight in ten days as one criterion of 'vigour'. This rate of recovery of weight could be measured.

The general well-being of the mother should be considered. According to Mr. Titmuss, one out of every eight pregnancies does not produce a baby alive at the end of one year. The attention of obstetricians is focused on the various catastrophes that happen between conception and the end of the first few months or less of the baby's life. But, socially, it is more important that seven mothers should be happy and feel well than that the eighth baby should survive. Is it impossible to devise some method of assessing well-being? It should at least be possible to compare the physical state of women before pregnancy with that, say, twelve months after delivery. This well-being may be unrelated to nutrition; but we ought to know.

In any future experiment it would be advisable either to raise the standard of the diet to a satisfactory level in every particular or to raise the intake of one constituent only; blunderbuss administration of a mixture of vitamins and minerals is unlikely to give clear results. Uniform criteria of, for example, prematurity should be adopted, and uniform methods of measurement fixed. At present, however, gigantic dietetic experiments are in progress. Prof. Huggett discussed the changes in diet due to rationing. As pointed out by Prof. J. R. Marrack, the supply of milk free or at a reduced price and the provision of cod liver oil and fruit juice have raised the general level of the diet of pregnant women above the average which existed before the War. Diets are now more uniform. A survey of the nutritional status and health of pregnant women now should give useful information on their reactions to standard conditions, and a comparison with pre-war records would indicate the effects of certain changes in diet.

We need to know more about the physiology of pregnancy. Why is it that a woman appears to need extra supplies of vitamins A, B_1 and C during pregnancy ? What is the purpose of the extra store of protein that is accumulated by a pregnant animal ? Why, as Dr. T. Moore pointed out, has a baby, at birth, such a low stock of vitamin A ? When we can answer these questions, we shall be in a better position to know what clinical evidences of deficiency we should look for and to lay down the food requirements of pregnancy. Prof. Huggett gave personal estimates of the levels to which the diet of a pregnant woman should be raised: 1–1·5 gm. of protein per kgm. of body weight, 1–1·5 of calcium and phosphorus, increased amounts of vitamins, particularly A, B_1 and D ; supplements of iron ; in terms of actual food-stuffs, more cheese, milk, vegetables and fruit. Until we have better knowledge of the physiology of pregnancy and more detailed evidence of the effects of diet on the health of mother and baby, we cannot assess the relative urgency of these demands. But pregnant women form such a small fraction of the total population and their health is of such importance, that they should, for the present, be given the benefit of any doubt and be allowed a prior claim on our food supply.

TRAWLING AND THE STOCKS OF FISH

IN a paper read before the Royal Society of Arts on January 27 on "Trawling and the Stocks of Fish", Dr. E. S. Russell, director of fishery investigations, Ministry of Agriculture and Fisheries, brought out in a convincing manner the problems which will confront us after the War in connexion with the national fish stocks of Great Britain and those of our near neighbours. In a summary of the history of the trawling industry from its beginning rather more than a century ago up to the present day, he traced its gradual growth. The demersal fishery, consisting of those fish living on or near the bottom, such as cod, haddock, hake, plaice and others, began with sailing boats fishing near shore. Then they ventured into the deep waters of the North Sea and, with the advent of the steam trawler and the great spread of fishing, went as far as Iceland and the Faroes, the Barents Sea and Bear Island, south of Spitsbergen. It is a tale of ever-increasing strength in boats and gear, and, running with it, an increase of fish—up to a certain point.

In 1866, a Royal Commission recommended that all restrictions on deep-sea fishing should be swept away and the industry allowed complete freedom of development—a measure which favoured enormously the later expansion of the trawl fisheries. It is a different matter nowadays. During the period of expansion there has been an almost continuous increase in the size and power of the steam trawler and in its fishing quality. It is a case of continued exploitation of the stocks of fish, beginning in a small way on grounds nearest at hand and spreading to all waters within reach, made possible by technical improvements in ships and gear and the building up of the fishing fleets in ever-growing strength.

The stocks of fish are not unlimited. The intense fishing made inroads into these stocks which are shown in the detailed statistics available, some of which were quoted by Dr. Russell. Those from the beginning of the century show a marked increase in the quantity of fish landed from 1886 to 1907; then follows a period of stabilization. With less fishing, landings necessarily fell heavily in the war period during 1914–18, in 1919–20 recovered to a level rather higher than pre-war, and in 1928 were not very different from 1907–13. Then comes a time when there is a sign of over-fishing. The landings fall off notwithstanding improvements in gear, and the average size of the fish is less. In spite of the fact that the war years had made it possible for the fish to recuperate, the very intense fishing which came after had made inroads on the stocks which could not be balanced. The only exception to the diminution of the stock was the cod in the extreme north. Here the fish were so unusually abundant, owing to changed hydrographical conditions, that this fishery itself was obliged to exercise restriction. Apart from the cod, the density of all the important demersal fish was steadily diminishing. Over-fishing was clearly the cause. The fish were not allowed to grow up.

At this point the present War broke out : once again, far fewer vessels are engaged in the fishery, once again the fish have recuperated and have grown to their full size and strength. After the War of 1914–18, enough was not known of the causes of these diminishing stocks. Modern research gives us no such excuse. As Dr. Russell states : "A conclusion of great importance has been reached, namely, that in most fully developed fisheries a state of over-fishing has been reached, a state where the ever-increasing intensity of fishing has resulted, not in an augmentation of the catch but in a diminution". He illustrates this by the haddock statistics, but it is the same story with almost any of the other important demersal fish. He has dealt with the subject fully in his recent book, "The Over-Fishing Problem" (Cambridge, 1942).

There is a grave warning here. Already something has been done by enlarging the mesh of the nets in order that immature fish may escape, but the question of immature fish, important as it is, is not nearly so important as the question of over-fishing. Canada has already so successfully controlled her halibut fishery that it has improved enormously.

With recuperated stocks and fishing fleets greatly reduced by the ravages of war, there are now exceptional opportunities to plan a more rational exploitation of the fisheries of Great Britain, and for this it is evident that international agreement will be needed. The object of such agreement will be to secure from each fishery area the maximum steady yield that the stocks can afford—to draw the interest while leaving the capital untouched. The only cure for over-fishing is to fish less, but with our improved knowledge it is clear that proper control will bring better profit to the industry and will lead to an increase, rather than a decrease, in the amount of fish landed.

ATMOSPHERIC POLLUTION*

By DR. G. M. B. DOBSON, F.R.S., and DR. A. R. MEETHAM

ONE might think that the trouble of atmospheric pollution was a result of the industrialization of Great Britain during the past hundred and fifty years. It is therefore interesting to turn to John Evelyn, who wrote of London in 1661:

> "And what is all this, but the Hellish & dismal Cloud of SEA-COALE? which is not onely perpetually imminent over her head; but so universally mixed with the otherwise wholesome & excellent aer, that her Inhabitants breathe nothing but an impure & thick mist, accompanied with a fuliginous & filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the Lungs, & disordering the entire habits of their bodies; so that Catarrs, Phthisicks, Coughs & Consumptions, rage more in this one City than in the whole earth besides."

Hence the trouble is no new one. However, no major attempt was made to obtain accurate records of the pollution in towns until about 1912, when a small committee under the chairmanship of Sir Napier Shaw designed suitable instruments and arranged for regular observations to be made which have gone on until the present day. Now it may be asked what good has been done by the very great amount of work which has been put into these observations. The answer is that without them there is no means of knowing whether the trouble is getting better or worse; whether big changes—for example, construction of the great power stations in London—have appreciably affected conditions, and whether legislation designed to reduce the evil has in fact had any effect. It would have been of great interest if John Evelyn could have made even the simplest observations to show the intensity of pollution in his day.

The pollution usually found in towns can be divided into three distinct classes: (1) 'Smoke', which consists of black carbonaceous matter formed by the imperfect combustion of fuel. This is mainly in the form of very small particles which float for a long time in the air, only settling out very slowly. (2) 'Ash' or grit which is thrown out with the flue gases and comes chiefly from industrial plants where the velocity of the flue gases is high. Such ash consists of much larger particles than 'smoke' and therefore settles relatively quickly out of the air in the immediate neighbourhood of the chimney discharging it. (3) Finally, there are the corrosive sulphurous gases. Of these, sulphur dioxide is generally the most important and comes from the sulphur always present in coal to the extent of 1–4 per cent. These gases are removed by being dissolved by clouds and rain or by reacting with stonework and the like.

The instrument which has been longest in use to measure the amount of pollution is the deposit gauge. This consists of a large glass funnel into which rain and impurities fall, to be collected in a bottle below. The object is to measure the amount of pollution settling out of the atmosphere on to buildings, trees and the like. The deposit is collected once a month and weighed and analysed into its chemical constituents. The gauge is not one of the most useful instruments, since it tends to collect material such as dust which is blown up by the wind.

In order to measure the amount of black polluting matter suspended in the air Dr. J. S. Owens designed the automatic filter; in this, air is drawn through a filter paper which removes the dirt, the amount of which can be estimated from the blackness of the stain produced. The position of the filter paper is changed automatically once or twice an hour so that variations in pollution throughout the day are recorded. The fact that only black matter is shown on the filter paper is no great disadvantage since most of the dirt usually found in the air is black. It has been shown that the greater part of the dirt caught by the filter consists of carbonaceous matter floating as very small particles in the air and may be described as 'smoke', in contrast to the larger inorganic particles of 'ash' which quickly settle out of the air. A filter can be connected in the pipe supplying air to the apparatus for measuring sulphur dioxide and in this case the filter is changed once a day. A variation of this type of filter has been designed which can be weighed before and after exposure, thus determining directly the weight of suspended matter in a given quantity of air.

Smoke is well known to have the effect of reducing the ultra-violet and visible daylight received in towns, and several instruments have been designed to measure this. Two have been used to enable a count to be made of the number of particles floating in the air. The first, designed by Dr. Owens, drives a jet of damp air at a high speed against a glass plate, when many of the particles are deposited on the glass, though some of the smaller ones may escape. The second instrument, designed by Mr. H. L. Green, uses the principle of thermal precipitation by which dust in warm air is deposited on any cold object. In both instruments the particles are counted with the aid of a microscope, and since the number of small particles that can be seen depends both on the illumination and on the magnification used, standard conditions must be employed if comparable results are to be obtained. If we wish to know the total number of particles present in the air down to the very smallest, we must use the Aitken dust counter, which uses the fact that if damp air is rapidly cooled by expansion, water droplets are condensed on each particle. The water drops fall out on to a polished metal surface and can be counted with the aid of a lens, but since there are so many it is usually necessary to dilute the sample of dirty air with a large volume of clean air to get a reasonable number to count. The number of these particles varies greatly, from some ten million per cubic inch in town air to a thousand or so in the cleanest country air. Some of the particles found in country air are produced naturally and are not due to human activities.

Finally, we come to the gaseous pollutions. The total acidity (mainly due to sulphur dioxide) is measured by passing a known quantity of air through a solution of hydrogen peroxide and titrating the resulting acid after 24 hours. We may determine what may be called activity of the sulphur gases by measuring the rate of sulphation of a standard surface of lead peroxide and in this way obtain a figure which will give an indication of the very much slower rate of attack of stonework, etc., by the sulphur gases. The latter apparatus has been found to be very useful since many sets can easily be exposed in different places—usually for a month—and then analysed.

Turning now to the results that have been obtained with these instruments, we take first the deposit gauge. Of the total catch, part is soluble in water and part insoluble. Some of the insoluble matter is dust blown up by the wind, and is often found to increase in dry weather. Much of the remainder comes from the nearest two or three industrial chimneys. The weight of soluble matter is very closely related to the rainfall, and there is little doubt that the rain removes a considerable amount of the sulphur gases in the air. The sulphur dioxide is mainly caught by cloud droplets as they float in the air rather than by the rain falling through the air. This is indicated by the fact that the amount of sulphates, for example, deposited with the rain falls off much more slowly outside a town than the amount of sulphur dioxide in the surface air. The sulphur dioxide at cloud level will be much more uniformly distributed than that in the lower air.

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* Being the substance of a Friday evening discourse entitled "The Air We Breathe in Town and Country" at the Royal Institution on February 12. Acknowledgement is made to the Department of Scientific and Industrial Research for permission to refer to unpublished results of the survey of atmospheric pollution at Leicester.

The results from the automatic filter may be used to show how the amount of smoke varies through the day. As might be expected, the air is cleanest in the early morning just before the first fires are lit for the day. A rapid increase of smoke then occurs, reaching a maximum in the middle of the morning. A shallow minimum during the afternoon is partly due to a reduction in the amount of smoke produced at this time and partly to the increased turbulence of the air in the middle of the day, which removes some of the smoke from street level. A second maximum in the late afternoon, which may or may not exceed the morning maximum, is caused partly by cooking the evening meal and partly by the reduced turbulence at this time of day. A remarkable result that comes out of these observations is that even under conditions of very stagnant air which causes a thick smoke haze during the day, the air in the early morning is comparatively clean. Even a thick fog, which in the evening has become a 'pea-souper' by picking up smoke, is found to be a nearly white fog, resembling a country fog, in the early hours of next morning; in other words, yesterday's fog has been removed or deposited during the night and a new clean fog has taken its place only to become as dirty as its predecessor during the coming day.

Although most measurements of acidity in the air take a single sample running for 24 hours and so cannot show the diurnal variation, yet a few hourly measurements have been made. These show a maximum of acidity during the daytime, but since the lighting of fires produces no extra acidity in the way that it produces extra smoke, we should not expect the morning maximum to be so marked. This is what the observations show to be the fact.

Both smoke and acidity show strong annual variations, with a maximum in winter and minimum in summer. This is natural both because more fuel is burnt in winter than in summer and also because the greater turbulence in summer will carry smoke and acidity more rapidly upwards.

The reduction of daylight—and particularly of ultra-violet light—near the centre of a large town by the smoke may be very great, and the proportional reduction is much greater in winter than in summer, although there is more need for ultra-violet in winter. This is partly due to the greater amount of smoke in winter and partly to the fact that the more oblique rays of the sun must travel a longer path through the smoky air. On a bad day in winter in London, nine tenths of the daylight is probably lost because of smoke alone.

In order to study atmospheric pollution in cities throughout Great Britain, the organization started under Sir Napier Shaw is still in existence; nearly sixty municipal authorities co-operate in making measurements of the pollution of the atmosphere within their respective towns, all the results being co-ordinated by a central committee under the Department of Scientific and Industrial Research, which carries out central services for this co-operative scheme. A large amount of information has been collected in this way during the last twenty-five years about the pollution at selected points in a number of cities. This information is very valuable in showing whether the pollution is getting better or worse, but it is usually not possible for any one city to run more than one or two stations, and we should never in this way have found out much about the distribution of pollution in different parts of a town. Again, since it is probable that the instruments set up in different towns will not be in comparable positions, we could say little about the general cleanness of one town as compared with another. What is perhaps more important still, is that we had little information about the 'life-history' of pollution after it left the chimney, and how it was removed from within the town, and how it was finally removed from the atmosphere. For this reason the Atmospheric Pollution Research Committee of the Department of Scientific and Industrial Research recommended that a thorough investigation should be undertaken into the distribution of pollution within one typical town. The city finally chosen was Leicester, since it is a large industrial city and is fairly well removed from other large towns the pollution from which might complicate the results. The authorities of the City of Leicester gave every possible assistance and two full years observations were made there at a dozen different situations in the centre of the city, in the suburbs and in the country surrounding it. Observations of smoke, sulphur, acidity and daylight were made at all these sites. Later, observations were made for a short time at a few other stations to clear up special points.

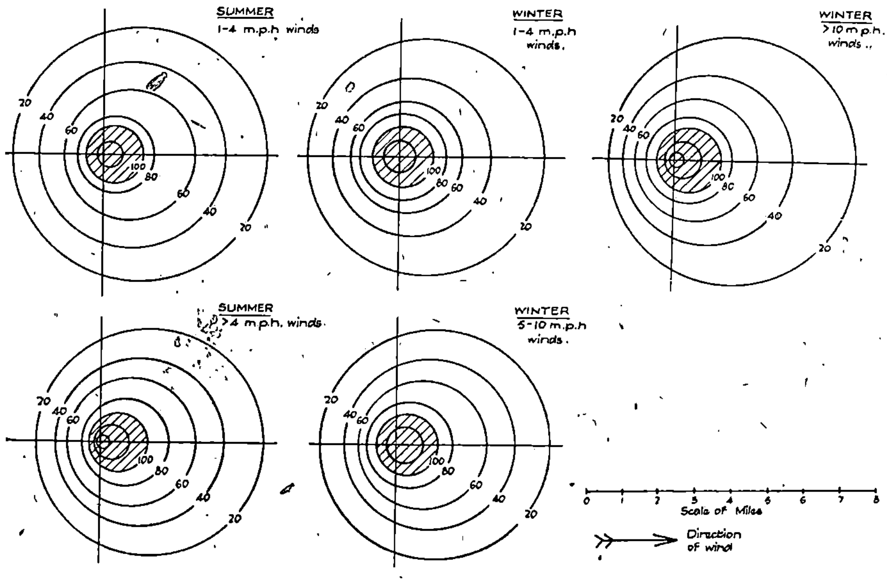
Curves for smoke and sulphur dioxide or acidity show distributions generally similar; the maximum density of pollution coincides closely with the centre of the city.

A point of great interest is the effect of wind on the distribution of pollution. The accompanying illustration shows the distribution of smoke for light and moderate winds in summer and for light, moderate and strong winds in winter; the intersections of the straight lines indicate the centre of the city. At first it is very surprising that in all cases the highest pollution is found close to the centre of the city rather than some distance downwind from the centre; and the general distribution—indicated by the circles—is little distorted by the wind, while the pollution added by the large city of Leicester was under most conditions difficult to detect above the general level of pollution in the surrounding country only a few miles downwind from the centre of the city.

In an earlier research the number of particles found by the Owens dust counter was recorded at various distances downwind from the centre of Norwich. Although this work was less detailed than that at Leicester, it again showed that even in strong winds the maximum number of particles was always found very close to the centre of the city and fell off rapidly downwind. It showed also that an increase of wind, by say three times, only resulted in a decrease of the pollution at the centre by about 30 per cent. At distances of more than five miles downwind the number of particles was nearly constant.

From these diagrams it is quite clear that somehow or other smoke is quickly removed from the surface air where the measurements are made. If there were no removal of smoke, the concentration would steadily increase as the air passed across the city—more rapidly when passing over the centre of the city and more slowly as it passed over the outskirts—so that the densest pollution would be somewhere near the leeward edge of the city. It is possible that the removal of this smoke is affected in three ways: by diffusion sideways across the wind direction, by deposition on to the ground and by spreading upwards. Diffusion sideways could not account for the rapid fall in pollution at a distance downwind from the centre which is small compared with the width of the city. The deposit gauge gives no sign that deposition is sufficiently rapid to give the effect, and we are left to conclude that diffusion upwards into the upper air is the really important factor.

Of course, the smoke is finally carried away from the city area by the wind aloft, but it seems that it is the removal of smoke from street level into the air a few hundred feet up that prevents smoke accumulating to a far greater extent than it usually does. That this is really the case is borne out by observations on days when the meteorological conditions are such that upward diffusion is stopped, for we find on these days that a dense smoke haze is quickly formed. The amount of upward diffusion is determined both by the change of temperature of the air with height and by the wind. When there is a cool layer of air near the ground with a warmer layer above, there is little vertical mixing of the air, and these are the conditions when smoke accumulates excessively near the ground. A strong wind will cause a reduction of smokiness, but this is more because it increases the vertical mixing than because it carries smoke away horizontally. This accounts for the observed fact that the reduction in pollution at street level is much smaller than the relative increase in wind velocity.



Although the smoke produced in towns is removed from the street level mainly by diffusion into the air overhead, it must eventually be removed from the area of the town by being carried away by the wind, and it will go to pollute the air over the surrounding country. Since the pollution from towns is dispersed through a great depth of atmosphere by the time it has drifted many miles away, the actual concentration in surface air will be small and may be difficult to detect in the presence of quite small local sources of pollution. On the other hand, the total mass of pollution through the whole thickness of the atmosphere may be great, so that it greatly affects the visibility and the colour of the sky. This makes the study of the pollution in districts far removed from its source rather difficult, and other methods may have to be used than those employed successfully in towns.

Up to the present time, no thorough study of the spread of the smoke over the country has been made, but it is easy to see its effects at great distances from towns. It has been estimated that, during westerly winds, a point some four miles to the east of Leicester receives about 30 per cent of its pollution from Leicester, about 25 per cent from the Birmingham district which is 30–45 miles away, and 45 per cent from elsewhere. North-easterly winds bring the least pollution to the Leicester district from outside since there are no large towns in that direction for many miles. At Oxford, south-westerly and westerly winds generally give very good visibility, but the smoke from the Midlands some sixty miles away produces much haze when the wind is north-westerly or northerly. With moderate or light northerly winds the visibility may be quite good during the morning, but about noon the Midland smoke can be seen arriving while the visibility decreases and the blue sky becomes whitish.

Turning to the effect of pollution on the light received in different parts of Leicester, we find that in summer, when the amount of smoke is generally low, the reduction even at the centre of the city is small, but in winter the decrease is very appreciable and in December the centre of a city may receive less than half that received outside it. The insidious effect of pollution on public health is partly due to this reduction of ultra-violet light, and may be the greatest evil of all.

It may be well at this point to say a few words about the effect of pollution on town fogs. It is probable that the *number* of fogs in a city is not increased above those in the surrounding country; indeed, as is well known, since there is a small increase in air temperature in towns above that of the country outside and since the rain will run off from roofs and streets much quicker than from open ground, one may expect the air in towns to be slightly drier than that outside them. On the other hand, the *character* of any fog which is formed will be greatly changed. Since there are so many more nuclei on which water droplets can form, the fog is likely to be noticeably more opaque and each droplet will catch some of the dirt floating in the air, so that the fog will lose the white character it would have in the country and tend to become a black fog. The number of 'pea-soup' fogs in London seems to have become definitely smaller in recent years, but it is difficult to say exactly why this is so. Unfortunately, the output of pollution does not seem to have decreased in the same ratio, although there was a substantial decrease in the years 1918–23.

One way in which we can get an estimate of the amount of domestic and industrial smoke is to measure the pollution on the different days of the week. On Saturday afternoon and Sunday, a great proportion of the industrial fires, including office heating, will be out or very low. On the other hand, domestic fires will go on as usual or may be slightly increased. It is found that there is a fall on Saturday afternoons and a marked drop on Sundays except in purely residential districts, the percentage drop varying between the residential and industrial parts of a town. On the average, the Sunday pollution in the centres of towns is about half to three quarters of the weekday pollution, and as a very rough estimate we may take the smoke pollution to be two thirds domestic and one third industrial in origin.

There is a greater reduction of sulphur than of smoke at week-ends. This is because a greater proportion of smoke is produced from open fires in houses. In central Leicester on winter weekdays, two thirds of the sulphur is of domestic origin whereas three quarters of the smoke is of domestic origin. This all shows how much more wasteful of fuel we are in the home than in the office or factory. If domestic heating and cooking were done as economically as industrial heating and steam-raising, we should use less coal in houses than industries, not more. These figures refer to peace-time, of course.

It may not be out of place finally to take a look at the problem with a view to the future and see what could reasonably be done to remove the evil. Of the three evils, 'smoke', 'ash' and 'sulphur', it is reasonably easy to prevent the emission of ash from industrial plants without placing too great a financial burden on industry, and one may hope that this will be made compulsory. The ash from domestic fires is probably too small to cause a serious nuisance.

The removal of 'smoke' depends on burning fuel in a proper manner. There seems no reason why most industrial plants should make any great amount of smoke, and even now the best plants are practically smokeless. Smoke means loss of fuel and it should be in the interest of the industries themselves to burn their fuel efficiently. A reduction in domestic smoke is likely to come about through the ever greater use of gas and electricity for cooking and heating, while smokeless fuel may replace some raw coal. If district heating is widely adopted, it should also help very much. Any method of increasing the efficiency of the open grate would improve matters, but short of abolishing open coal-fires altogether, the most effective reform would be to consume the smoke emitted during kindling and refuelling.

From time to time there have been suggestions that 'smokeless zones' should be established in the centre of cities where no coal could be burnt in such a way as to produce smoke. The results of the detailed work at Leicester allow us to make a rough estimate of the effect. While such efforts are greatly to be encouraged, no striking effect is to be expected unless the smokeless zone is large, owing to the smoke from the surroundings which will be carried into it.

To prevent the emission of sulphur dioxide may prove to be the greatest difficulty. However efficiently coal is burnt, the amount of sulphur dioxide formed depends only on the weight of coal consumed and the sulphur content of the coal. Unless some means is provided for absorbing the sulphur before the gases are discharged into the air, little improvement can be obtained, though washing the coal removes some of the sulphur. Some of the great electric power stations have means of absorbing the sulphur gases, but from by far the greatest amount of coal burnt all the sulphur dioxide formed is discharged into the atmosphere. There is some hope that, in the not too distant future, apparatus for absorbing sulphur gases may be practicable for much smaller plants, but it is perhaps too much to hope that such means could be generally adopted for the domestic fire. If communal or district heating were introduced on a wide scale, the central plants might be fitted with sulphur absorbers. The use of coal gas (where almost all the sulphur is removed) or of electricity (provided sulphur-absorbing plant is installed at the power stations) on a very much greater scale than at present may be the final solution.

It is greatly to be hoped that in planning the new Britain all practicable measures to reduce atmospheric pollution will be adopted.

OBITUARIES

Mr. Rollo Appleyard, O.B.E.

Rollo Appleyard, whose death occurred on March 1, was one of those pioneer engineer-physicists who did so much during the last few decades of the nineteenth century to establish British electrical industry on a scientific basis. Born in 1867 and educated at Dulwich, he was fortunate, as a student at the City and Guilds Institute, to come under the influence of that great coalition Profs. Ayrton and Perry. Bedford College and Coopers Hill College in turn welcomed him afterwards on the physics side.

At the age of twenty-five, Appleyard joined the technical staff of the India Rubber and Gutta Percha Company at Silvertown, where he remained for twenty-two years. Among his colleagues at this time was Rymer-Jones, of world-wide submarine cable reputation, and during this period Appleyard devoted a good deal of time and thought to dielectric and conductor problems in submarine cables. He contributed many papers to the *Proceedings of the Physical Society*, the *Phil. Mag.* and to the engineering institutions, as well as articles to the electrical press. These covered a variety of subjects including electrical alloys, network problems, submarine cable testing and apparatus for this purpose, coherers, surface tension and thermometry. He was mostly interested in dielectric theory, and an outstanding example of his practical application of his knowledge of physics was the production of the submarine cable connecting Honolulu and San Francisco, in which he achieved the lowest dielectric constant obtained on any submarine cable to that date.

In the improvement of the conductor for long-distance submarine cables, Appleyard invented the 'conductometer', an instrument for the measurement of electrical conductivity, and his paper on the subject before the Institution of Civil Engineers gained him the Telford Premium in 1903. As evidence of his versatility and long interest in technical matters, it may be recorded that seventeen years later the award was made to him a second time, for a paper on the mathematics of catenaries. While at Silvertown he also devoted considerable thought to the physics and the development of the intricate mechanism involved in the formation of a golf ball core.

During the War of 1914–18, Appleyard worked in the Admiralty and Air Service, where his unique combination of practical engineering knowledge and physics training enabled him to make many contributions to the war effort, for which the O.B.E., as a mark of recognition, was conferred upon him. He introduced improvements in the measurement of height by barometer and the design of instruments used for many different purposes.

Throughout his life, Appleyard showed a marked literary talent which for many years revealed itself in his papers and articles. Towards the end of the War of 1914–18, he produced several valuable confidential reports for Government Departments, and directed for some time the technical history section of the Admiralty. He was a member of the editorial staff of *The Times Engineering Supplement* for some nine years from its establishment in 1905. As one of the abstractors in the early days of *Science Abstracts*, he did useful work, but perhaps he will best be remembered for his delightful biographical works: "Pioneers of Electrical Communications", "A Tribute to Faraday", and others. These, along with his "History of the Institution of Electrical Engineers", will for many years to come remind the members of that body, among whom he counted so many friends, of his engaging character. Mostly, perhaps will he be missed in those more intimate circles; the Athenæum, the 25 Club and the Dynamicables, where his grace and charming personality were always a delight to his fellow-members.

P. DUNSHEATH.

WE regret to announce the following deaths:

Sir Sidney Burrard, Bart., K.C.S.I., F.R.S., formerly Surveyor-General of India and superintendent of the Trigonometrical Survey of India, on March 16, aged eighty-two.

Prof. H. G. Denham, dean and professor of chemistry, Canterbury University College, Christchurch, New Zealand, and chairman of the New Zealand Council of Scientific and Industrial Research, aged sixty-two.

Prof. J. Eustice, emeritus professor of engineering at University College, Southampton, on February 24, aged seventy-eight.

Dr. F. G. Parsons, research fellow in anthropology at St. Thomas's Hospital and formerly professor of anatomy, University of London, on March 11.

Mr. H. E. Stilgoe, C.B.E., formerly chief engineer of the Metropolitan Water Board, and a past-president of the Institution of Water Engineers, the Institution of Municipal and County Engineers and the Town Planning Institute, on March 12.

NEWS and VIEWS

Cambridge University Botanic Garden

WHEN Mr. Reginald Cory, a graduate of Trinity College, died in 1934, he bequeathed the residue of his estate to the University Botanic Garden at Cambridge. Mr. Cory, who was himself a great gardener and helped to finance expeditions to China and other countries to collect plants that could be grown in British gardens, was a generous benefactor of the Cambridge Garden during his lifetime. His handsome final bequest has now begun to accrue, and from this time onwards the garden will benefit by £9,000, rising eventually to £13,000, a year. In accordance with the terms of the will, only £1,000 a year of the legacy can be devoted to maintenance, the remainder being available for capital expenditure, including the purchase of land for the extension of the garden. The Cory Fund will be administered by six members of the senate, including the Professor of Botany and the University Treasurer.

The Cambridge Botanic Garden, which is a part of the University Department of Botany, has already a deservedly high reputation, but there are now great possibilities of further enhancement, especially as regards the variety of plants cultivated in it and the general beauty of the Garden. In the past, many important botanical investigations have been carried out there, and in view of the opportunities now available it is anticipated that several branches of botany will be greatly assisted. Of the total area of forty acres, about eighteen have been used as garden allotments for many years. After the War, it may be considered desirable to incorporate these into the Garden proper. An arboretum is a great desideratum, but this may have to be established on a different site as the soil is unsuitable for certain conifers. The Garden at present lacks protection from the north and east, and a good wall against which the more delicate shrubs can be grown is an urgent necessity. Much greater facilities could be usefully provided for growing water-plants as there is a stream contiguous to the Garden. The range of glasshouses could also be advantageously extended, giving additional provision for the cultivation of ferns and bryophytes, and tropical and sub-tropical flowering plants. No doubt all these possibilities will be weighed by the managers of the Cory Fund.

Nature Reserve at Oxford

THE University of Oxford has accepted, as a gift from Mr. and Mrs. H. Spalding, eighteen acres of meadow land on the left bank of the River Cherwell opposite the walk known as Mesopotamia. This land is to be maintained as a nature reserve, to preserve in perpetuity a piece of water meadow, characteristic of the Oxford basin, for the enjoyment of the public, and to afford facilities for observation of the plants and animals inhabiting this type of land. The meadow land includes a small triangular area at its south end which, surrounded by old hedges, might, if suitably planted, develop into a woodland plot tempting to nightingales, which at present are not audible from Mesopotamia. The area is at two levels, that nearer the river being liable to flooding. The blight of suburban extension has already threatened that part farthest from the river with untidy neglected fields and huts, and the preservation of Mr. and Mrs. Spalding's gift will protect Mesopotamia from further spoliation of the river. Administrative control is to be vested in the Curators of the Parks who, in consultation with a committee of naturalists, will manage it in such a way as to carry out the objects of the gift. It will require enclosure, supervision, proper maintenance of drains and the continuance of traditional agricultural usage by annual mowing, and closure to grazing of at least certain parts.

Scientific and Industrial Research in India

IN its report which appeared during the War of 1914–18, the Indian Industrial Commission, over which Sir Thomas Holland presided, directed attention to the necessity of establishing a system of organized research if Indian industries were to be adequately developed. Unfortunately, in the post-war period little attention was paid to these recommendations, although in 1937 the late Lord Rutherford in the presidential address which he had prepared for the twenty-fifth meeting of the Indian Science Congress Association once more emphasized how greatly India would benefit by the formation of an organization similar to the Department of Industrial and Scientific Research. The present War, combined with the energy and foresight of the Hon. Dewan Bahadur Sir A. Ramaswamy Mudaliar, now a member of the War Cabinet, provided the necessary stimulus, and on April 1, 1940, the Board and Council of Scientific and Industrial Research was formed by the Government of India. Dr. (now Sir) Shanti Bhatnagar was appointed as the first director. The manifold activities and the great achievements of this research organization, due largely to the energy of its director, are little known in Great Britain, and we welcome, therefore, the new publication, *Journal of Scientific and Industrial Research*, issued by the Council, the first number of which has just been received.

The Board functions largely through a series of committees, some nineteen in number, which range from a Vegetable Oil Committee to one of Radio Research. At the present time, the research work of these various committees is carried out, under the general control of the director, in various university laboratories and at the Indian Institute of Science, Bangalore, but a National Chemical Laboratory is to be opened at Poona. This has been made possible by a munificent gift of 8 lakhs of rupees from Messrs. Tata Sons and 1 lakh of rupees from Messrs. Indian Wire and Steel Products Limited. Articles in the *Journal* discuss the possibilities of the manufacture in India of calcium carbide and thermionic valves and also the utilization of Bhilawan resin as a base for plastics. Interesting articles deal also with established Indian industries such as the Tata Oil Mills and the Juggilal Kamlapat group of mills. While agriculture must always play a predominant part in Indian economy, with her many resources, she can support also great industries. Doubtless future issues of this journal will furnish us with an account of some of these developed by the new research organization.

Industrial Health Advisory Committee

THE appointment by the Minister of Labour of an Industrial Health Advisory Committee, and the announcement by him of a three-day conference (in April) on industrial health, to which representatives of the Dominions will be invited, as well as representatives of organizations in Great Britain interested in the physical well-being of the working population, indicate a move in the direction of reform long overdue. The rapid mechanization of war, with its consequent emphasis on accurate large-scale factory work, has directed attention to the time lost in factories through petty illnesses and industrial hazards, mostly preventable. Most, if not all, of these hindrances to production existed in peace-time, but only a life-and-death war, with its vast increase in the factory population, has made it obvious that the standard of health of the factory worker is everybody's business—it is, in fact, a political question. True there are Factory Acts, providing a minimum standard of conditions in factories and protection against many industrial hazards, but their enforcement is entrusted to factory inspectors whose numbers—their zeal has never been in question—are wholly inadequate for the work they have to do. Nor is there much provision for research in industrial health, or much apparatus for the implementation of its findings. One of the duties of this new Committee will be to codify knowledge and help to bring it into use.

A comparatively modern development is the realization of the fact that the health of the worker is not merely the province of medical men and factory inspectors, but also of the worker himself. This is reflected in Mr. Bevin's suggestion that trade unions should take an interest in the preservation of health, and in those from other quarters that workers should help in the defence against industrial hazards and the teaching of industrial hygiene. Mr. Bevin hopes that Government, employers, managers and workpeople will co-operate to the full in providing factory conditions that will make work healthier, safer and more pleasant. The Committee will advise him how the Government can do its part. This valuable co-operation, for these honourable ends, must be continued after the end of the War, through the difficult times of transition and on into the era of peace.

British Council: New Institutes in West Africa

PROF. W. M. MACMILLAN, who has been working for the past two years in the Empire Intelligence Section of the British Broadcasting Corporation, has been selected by the British Council to act as its representative in West Africa. He will leave for the West Coast as soon as possible. His appointment follows a survey recently made by Mr. C. A. F. Dundas, the British Council's representative in the Middle East. It is hoped to establish institutes in the four West African Colonies, to serve as intellectual and cultural centres and to demonstrate the progress made in Britain in the fields of science, pure and applied, literature, art, music and drama. The necessary executive staff is now being assembled. Prof. Macmillan, lately professor of history and research fellow at the University of the Witwatersrand, Johannesburg, is a member of the Colonial Office Advisory Committee on Education in the Colonies. He has spent many years in Africa and several of his books are widely known; they include "Warning from the West Indies" (1936), and "Africa Emergent" (1938).

Mortality and Life Assurance Statistics

Sir William P. Elderton and Mr. M. E. Ogborn read a paper before the Royal Statistical Society on March 16 on "The Mortality of Adult Males since the Middle of the Eighteenth Century as shown by the Experience of Life Assurance Companies". Life assurance as we know it began in 1762, when the Society for Equitable Assurances on Lives and Survivorships was founded and, until early in the nineteenth century, this was the only company having a substantial number of lives assured on its books. The lives represent a provident type drawn from the professional and business classes, with a sprinkling of landed gentry on one hand and of clerks and servants on the other. Three mortality experiences were quoted: Arthur Morgan's, 1762–1829; H. W. Manly's, 1863–1893; and a recent experience, 1924–1938. The rates of mortality were light and show a steady decrease up to about age 77. In the most recent experience the rates of mortality are about one fourth of those of the first experience up to age 47, and rather less than one half of those of the second experience. The proportional fall decreases at the older ages until there is little change from age 82 onwards. As regards the general population, the English Life Tables Nos. 3, 5 and 10 were used for comparison as they correspond most nearly in date to the assurance experiences. From No. 3 to No. 5 the mortality decreased by about one quarter at early adult ages and by about one tenth between ages 30 and 40. From then onwards No. 5 shows an increase in mortality over No. 3, and even though the methods of construction and reliability differ it seems probable that mortality actually increased. From No. 5 to No. 10 there was a decrease of about one half in the rates of mortality up to age 47, dropping to one tenth at age 77, and showing on the whole a smaller decrease at the later ages. These changes are similar to those between the two corresponding experiences of the assurance offices, though the general population has, as would be expected, a higher mortality than that of lives assured.

Control of Infectious Diseases

IN a Chadwick Lecture given on March 16 by Dr. Robert Cruickshank, of the L.C.C. Group Laboratory, it was stated that although the mortality from infectious diseases has steadily declined in the past half-century, approximately one out of every five deaths is at present due, directly or remotely, to infection. To assess the effect of past measures and as a guide to new methods of control, the bulk of infectious diseases can best be analysed in four main groups: (1) acute respiratory infections; (2) tuberculosis; (3) intestinal infections; and (4) childhood fevers (whooping cough, measles, diphtheria, scarlet fever, in that order of importance). The pneumonias and bronchitis are pre-eminent as a cause of death among the infections (they are third on the list among deaths from all causes); sulphonamides have failed to produce any striking reductions in the death-rate from these causes. A promising beginning has been made in the control of influenza, but the common cold is still a major public health and economic problem.

The upward trend of tuberculosis in war-time—the causes are hypothetical—has helped to accelerate measures for its better control; the role of artificial 'vaccination needs fresh consideration' in Great Britain. Typhoid fever declined sharply coincidental with the introduction of the water-carriage system of sewage disposal, but paratyphoid, bacterial food-poisoning and bacillary dysentery are now more prevalent than they were. Their control will be closely linked with improved personal hygiene, particularly of food-handlers. The highly fatal gastro-enteritis of infancy is an unsolved problem needing urgent attention. Whooping cough is the most serious of childhood infections; it can be prevented or attenuated by prophylactic vaccination. Measles, itself a mild disease, is a menace because of its secondary complications. Diphtheria may not be wholly preventable but should cease to cause death. The means by which improvements in the control of infectious disease can be effected are: (1) administrative regionalization (with the medical officer of health, the practitioner and the bacteriologist as co-operative partners); (2) structural (improved design and equipment of hospital, school and home); (3) educational (of child, parent, nurse, student, medical man); (4) preventive (better feeding, better hygiene, artificial immunization, new methods for the control of air-borne infections).

Mild Winter of 1942–43

THE break in the series of severe war-time winters in Great Britain effected by the mild weather at the end of 1942 and in the early part of 1943 had an interesting effect upon the wild life of the English countryside compared with the previous three winters. Although in Scotland wildfowl and wild geese were reported to have been as numerous as in the previous season, in most parts of England the golden-eye, a characteristically abundant visitor in the previous war winters, was much less numerous. In west Cumberland in the middle of February the hatching of brown trout and sea-trout eggs was reported to be some thirty days in advance of the previous seasons, although in an article on "The Spawning Habits of Salmon" in the *Field* (February 6), G. M. King, clerk to the Dee Fishery Board, contends that in thirty-four years' experience he has failed to find that prevailing weather conditions affect the spawning time of these fish. In other parts of Lakeland there were many plants of red dead nettle, shepherd's purse, red campion, ivy-leaved toadflax, etc., in flower at Christmas. Over England generally the yellow winter jasmine was reported to have given one of the finest flowering displays for many years, and the songs of the song-thrush and skylark commenced several days earlier than usual. The missel-thrush was reported sitting on its nest in North Wales in February, and the song-thrush nest-building in Lancashire on February 6, and sitting on eggs on February 17. In Sussex and most other parts of Great Britain the exceptionally early pairing of partridge was also noted; in Cumberland these birds had paired by Christmas. Another Sussex feature was the early breeding of rabbits. From the Home Counties there were many early reports of hazel flowers, male and female, recorded in the *Times* in January.

Recording Technique in Electro-Biology

AN interesting paper entitled "Amplifying and Recording Technique in Electro-Biology, with Special Reference to the Electrical Activity of the Human Brain" was read by G. Parr and W. Grey Walter at a meeting of the Wireless Section of the Institution of Electrical Engineers on March 3. One of the fundamental properties of the living cell is the production of an electromotive force, which changes when the cell is stimulated into activity. In order to study the nature and magnitude of these biological E.M.F.'s, special amplifying methods and input circuits are required, operating suitable visual, photographic or pen-writing recorders. The paper referred to reviews the standard methods of obtaining records, and the application of these to the recording of the potentials in the human cerebral cortex. The magnitude of the potentials produced by the brain varies from 5 to 1,000 micro-volts; it is of alternating wave form, of frequencies ranging from 1 to 20 cycles per second, and very irregular. The frequency of the output from an abnormal brain (for example, epileptics and cases of cerebral tumours) differs appreciably from that of the normal, and from this and other indications it is claimed to be possible to diagnose mental diseases and locate with considerable accuracy the sites of tumours.

Although the records in most cases show a wave form of a main predominant frequency, this is frequently interrupted by irregular groups or bursts of waves of other frequencies. These irregularities have a definite clinical significance, and it is therefore of importance to analyse the record accurately to determine the frequencies present. The authors described a tuned reed autographic analyser which has been developed for this purpose, and showed an example of its application. The reading of the paper was accompanied by a demonstration on a human subject, in which the varying effects of permitting the brain to rest and of stimulating it into activity were shown by records on a cathode ray oscillograph.

Golden Gate Bridge

INSTRUMENTS have recently been installed on the Golden Gate Bridge at San Francisco for accurate recording of movements that occur under wind loads (*Earthquake Notes*, 14, Nos. 1 and 2; 1942). These include a wind velocity recorder, a wind directional recorder and a non-sensitive recording seismograph. Vertical and horizontal graduated boards at midspan will facilitate observations with a transit to measure movement in these two planes. The wind vane and anemometer are mounted on a structural steel platform on the west or ocean side of the bridge at midspan. Both these instruments are electrically connected to motor-driven recording units in the east leg of the south tower. At this point a 24-hour continuous record is maintained from the two wind instruments and the seismograph. With these records it is expected that useful information will be obtained as to the various movements caused under different wind conditions; for example, as in the case of a 72 m.p.h. wind such as was recorded during a storm in 1938.

Earthquakes Registered in New Zealand

DURING November 1942 ten earthquakes were registered by the seismographs at Auckland, Arapuni, Christchurch, Kaimata, New Plymouth, Tuai and Wellington, according to a seismological report just received (*Prov. Bull.* No. P-129, November 1942, Dominion Observatory, Wellington W.1, New Zealand). The greatest was on November 10 when the trace amplitude on the Z record was 12 mm. This earthquake began recording with P compression at 11h. 53m. 45s. U.T. from an epicentral distance of 82° and from an azimuth south-south-west of Christchurch. The shock of November 3 had a focal depth of 350 km., and the next deepest focus occurred on November 7 (180–200 km.). The most intense of the twenty-six earthquakes felt during the month in New Zealand had intensity 5 on the Rossi-Forel scale. This occurred on November 26 at 1h. 31·6m. U.T. from an epicentre near latitude 41° S., longitude 172·3° E. Masterton was most often affected during the month, and Wellington experienced three small shocks on November 3, 7, and 14.

Activity on Jupiter's South Equatorial Belt

MR. B. M. PEEK, director of the Jupiter Section, British Astronomical Association, reports a remarkable outbreak of activity in Jupiter's South Equatorial Belt. This outbreak commenced at some time between February 7 and 11 in System ii longitude 15° approximately. It is possible that there will be a repetition of the phenomena of 1928–29. The preceding end of the disturbance is advancing rapidly along the north component of the belt in the direction of decreasing System ii longitude: the main features, however, are not rotating so rapidly as System i. In the following portion there are some dark humps on the south component of the belt, the System ii longitude of which is increasing rapidly. Assuming that the rate of drift is maintained, the first of these humps—which is more like a streak than a hump—should reach conjunction with the preceding end of the Red Spot in the first week in April. One important difference between the present outbreak and that of 1928–29 is the appearance of a second centre of disturbance on March 1 about longitude 290°, System ii. Mr. Peek conjectures that the preceding end of the whole disturbed region may soon pass to the north of the Red Spot. If this should occur, it would cause the Red Spot Hollow, which has recently been very faint, to grow darker again.

Variation in δ Ursæ Majoris

A BRIEF notice about the variation in the brightness of this star appeared in NATURE of February 6, p. 165. Additional corroborative evidence is afforded by further observations by Mr. N. F. Knight in North Africa, and Mr. F. M. Holborn at Streatham, London. Mr. Knight's latest observation, made on February 2, gives the magnitude 3·5–3·6, and Mr. Holborn had recorded the same magnitude on February 2. Mr. Holborn's most recent observations on February 26 and March 4 show that the star is now practically back to its normal magnitude, 3·4. It may be recalled that Mr. Knight estimated its magnitude as 3·8–3·9 on December 10, and on January 14 and 15, Mr. Holborn's estimate was 3·7.

Announcements

DR. H. SPENCER JONES, Astronomer Royal, has been awarded the Gold Medal of the Royal Astronomical Society for his determination of the solar parallax.

SIR BENNETT MELVILL JONES, professor of aeronautics in the University of Cambridge, has been appointed chairman of the Aeronautical Research Committee in succession to Sir Henry Tizard.

THE University of Sheffield has received a gift of £800 from an anonymous donor to provide equipment for the Department of Geology after the War.

Mr. A. Wright has resigned from his post of lecturer in mining, on his appointment as senior investigator to the Lancashire and Cheshire Safety in Mines Research Committee.

THE Director of the Seismological Institute of the University of Chile reports that a new seismograph consisting of both horizontal and vertical components is being installed at the University in Santiago, Chile.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Making of a Research Worker

MANY of the comments made in the editorial article "The Making of a Physicist" in NATURE of August 29, 1942, p. 245, apply generally to British scientific research workers, including those engaged in agricultural research.

The Imperial College of Tropical Agriculture[1] is peculiar in that the primary purpose of its existence is the postgraduate training of the young men who are to become members of the Agricultural Service of the British Colonial Empire. Even the research work of the College, important as it is on its own account, is yet in a large degree ancillary to this prime consideration. The College has been in existence for some twenty years and its present postgraduate course has been gradually evolved during that time. The remarks in the article mentioned above are thus of great interest to the academic staff of the College, and it may be that our views and experience will be of interest to the readers of NATURE.

Our course consists partly of direct lecture-room and laboratory instruction and partly of independent research or experimental work by the student, leading to the preparation of a dissertation—in fact "the apprenticeship in research" described in the NATURE editorial article.

There can be few to-day who would question that the graduate in applied science who aspires to become an investigator or research worker should be given special postgraduate training before he embarks upon his career; but the apprenticeship in research is by no means the only method that can be conceived for giving such special postgraduate training to the future research worker. It is quite feasible to give him direct instruction in the general principles of research work, in the special mathematics of experimental work, and in the modern technique of research in his own particular subject. Indeed by means of courses of that type it is possible to give the student a more complete equipment of the special technical knowledge he needs than he can gain under the apprenticeship system. In the postgraduate course at this College we deliberately employ both methods, and it would be difficult to say to which we attach the more importance. But it can be said that we certainly do not attach any less importance to the apprenticeship scheme as a result of twenty years experience in the practice of training research workers in agriculture and the various sciences allied thereto.

Before I personally came to this College I had had, in my capacity of a Director of Agriculture, experience of the work of a good many of its 'associates'. I had found them generally very good men at their jobs. None the less, for reasons which need not be detailed here, I had still a very open mind about this apprenticeship in research as a part of their training. Now, after a few years association with the postgraduate training given here, and of watching the development of the young men while they are receiving it, I have become convinced that a real apprenticeship period is an essential part of the ideal training of a research worker—just as essential as the direct formal instruction in the research technique of his subject. The apprenticeship is necessary as a means of educating any gifts of scientific thoroughness, judgment and outlook with which the student has been endowed by Nature; and working as a junior in a research institute is not the same thing as a proper apprenticeship.

In the NATURE editorial article, it is stressed that the clear objective of this system must be the training of the research worker, not the conducting of research; and it is rightly pointed out that the temptation must therefore be avoided to use the research student as an observer in other men's research work, that is, the student must not be an extra pair of hands for his tutor. It is also pointed out that the god of 'communications' is a false god whose worship must be avoided; but no mention is made of what our experience leads us to regard as yet another cult that can be carried too far, namely, that of the dissertation.

The striking difference between the conditions under which a man works while he is a research student and those under which he will work later is that in the former capacity he has perforce to produce his dissertation at a certain fixed date, marking the end of his apprenticeship. He is thus instructed, as it were, to 'publish his results' as early as possible. Yet when he becomes a paid worker he will be, or should be, equally strongly discouraged from anything savouring of premature publication. The preparation of a report or dissertation at the end of the period of training is unquestionably an entirely essential part of the apprenticeship system. But unless special care is taken, it can easily become the chief object of the student's work as an apprentice: whereas his object during that time should be to do good work, and the report or dissertation is but the record of the work he has done.

It should be made clear to the student at the beginning that the gaining of his postgraduate qualification will depend upon his showing his ability to do research work and report his results intelligently. The main function of his dissertation is that of a record: the dissertation is not a sort of glorified examination paper in which the gaining of high marks is the one and only essential for the winning of the postgraduate qualification. Again, it is suggested that for students at this stage it should be an absolute rule that the publication of a dissertation *in extenso* is never permitted. (No doubt for men at a later stage, qualifying for a doctorate, the position is different.) The research student may be permitted to use, in a published paper, the data which he has obtained in the course of his apprenticeship, or his tutor may use the data with due acknowledgement. But the knowledge that his dissertation can never be published entirely *in extenso* will go a long way to stop the student losing his sense of proportion as to the relative importance of the work he does and of the report he writes about it.

It is mentioned that his own mistakes are part of the apprentice's training. I would add that so also should be the mistakes made by earlier students in the same institution, as recorded in the filed dissertations on problems related to his own. The extreme degree of conciseness and elimination of non-essentials that is so desirable in publications nowadays need not be required in a dissertation. This factor seems to make a body of earlier dissertations particularly instructive for students. Each year's students learn by the mistakes of their predecessors, even as they contribute similarly to the education of their successors.

From what has been written above, it will be realized that, on the administrative side, there is one factor which is most important in a good training of this kind, namely, a high proportion of 'masters' to 'apprentices'. The number of research students that one senior research worker can handle satisfactorily must obviously vary to some extent with the nature of his subject and the kind of problems he gives to his students; but it is doubtful whether in any circumstances research students can have the best possible guidance if the number of apprentices supervised by one tutor exceeds five. In some subjects the number must not be even so high as that. This means that such postgraduate training of research workers, if it is to be really good, must be expensive. But the men trained should be very valuable material which is being made into something of first-rate importance. It should therefore be worth while to spare nothing that will contribute to the making. It would be hard to conceive of any more interesting and satisfactory duty for a scientific man than the making of a research worker out of a good graduate. In order not to end on a note of pessimism, we must say nothing about the 'master's' feelings on the rare occasions when he suffers from an ill-chosen 'apprentice'.

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[1] See NATURE, **147**, 282 (1941).

Behaviour of Thiuram Sulphides, etc., in Spore Germination Tests

SOME seven years ago, in the course of sorting tests of potential organic fungicides, it was noticed that tetramethylthiuram monosulphide sometimes gave irregular results. In certain tests an 'inversion' of toxicity occurred, that is, within a limited range of concentration, toxicity to fungus spores (*Venturia inæqualis*) decreased as the concentration of fungicide increased. When this effect was first observed it was ascribed to some experimental mishap, but it was repeated with sufficient frequency, though not invariably, to convince us that the phenomenon was authentic. It was later seen in the case of tetramethylthiuram disulphide, though not before several tests had been completed without any indication of it, and has been investigated most fully in relation to this compound. Confirmation of the effect has since been provided by the independent observations on the latter substance reported by Dimond *et al.*[1], using spores of *Macrosporium sarcinæforme*.

Substance	Concentration per cent				
	0·1	0·01	0·001	0·0001	0·00001
Thiuram disulphide	*B*	*D*	*D*		
Tetramethylthiuram monosulphide		*A*	*B* (0·0075)	*C* (0·005)	*B* (0·0025)
,, disulphide			*A*	*B*	*D*
Tetraethylthiuram ,,		*A*	*B*	*B*	
Dimethyldiphenylthiuram ,,	*E*	*E*	*E*		
Diethyldiphenylthiuram ,,	*E*	*E*	*E*		
Dicyclohexylthiuram ,,	*D*	*E*	*E*		
Dimorpholylthiuram monosulphide	*C*	*B*	*C*		
,, disulphide	*A*	*B*	*D*		
Dipentamethylenethiuram monosulphide			*C*		
,, disulphide	*A*	*A*	*B*		
,, tetrasulphide			*E*		
,, hexasulphide			*E*		

A, no spores germinated; *B*, mainly ungerminated; *C*, many germinated; *D*, mainly germinated; *E*, all germinated.

We are now able to report that, far from being an isolated occurrence peculiar to the tetramethylthiuram sulphides, this property of 'inversion' of toxicity is shared by some other thiuram sulphides and some dithiocarbamates. It is probable, indeed, that it is a general property of these groups, still unnoticed in some cases because the range of concentration—often a very narrow one—within which it occurs has not yet been located. This is illustrated by the accompanying table giving qualitatively the results of a preliminary survey of some thiuram sulphides.

Only in the case of tetramethyl- and dimorpholylthiuram monosulphides was 'inversion' apparent. When, however, a more critical comparison was made with the view of obtaining quantitative data on the relation of molecular constitution to toxicity, narrower ranges of concentration were examined and 'inversion' was established in the following cases.

Tetramethylthiuram monosulphide
,, disulphide
Dimorpholylthiuram monosulphide
Dipentamethylenethiuram monosulphide
,, disulphide

as well as in the case of

Sodium diethyldithiocarbamate
,, morpholyldithiocarbamate
Zinc ,,
Sodium pentamethylenedithiocarbamate
Piperidine ,,

A variety of hypotheses could be advanced to explain this behaviour on biological, physical, or chemical grounds, but thus far little positive evidence in support of any is forthcoming. Certain considerations can, however, be put forward. The occurrence of the phenomenon in relation to two organisms as different in character as *V. inæqualis* and *M. sarcinæforme* suggests that a biological peculiarity in the response of the organism is not a probable explanation. Again, an explanation on purely physical grounds, such as changes of solubility relationships or in particle size or structure on dilution, seems to be inadequate since the substances cover a range from the very freely soluble to the almost insoluble, and include both the crystalline and the amorphous. It is likely, therefore, that explanation must be sought primarily in the chemical reactions of these notoriously labile substances, and experiments with this objective are now in progress.

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Feb. 22.

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[1] Dimond, Horsfall, Heuberger and Stoddard, Conn. (New Haven) Agric. Exp. Sta. Bull. 451 (1941).

A Middle Pleistocene Discovery in the Anglo-Egyptian Sudan

Andrew's and Arkel's important discoveries of Chellean-type and Acheulean-type artefacts in the 5 m. ironstone gravels of the Khor-Abu Anga, and elsewhere near the confluence of the Blue and White Niles[1], is consistent with results obtained in the Lake Plateau Basin of the Nile farther south, where it is plain that erosion levels were not very different from those of to-day, first in "pre-Chellean" and, later, in "Chelleo-Acheulean" times. There is, moreover, striking evidence of "post-Acheulean" sedimentation to higher levels and the consequent deep burial of "Chelleo-Acheulean" and afterwards of "late Acheulean" land surfaces (flats) which had been brought into existence by temporary but relatively long-sustained low levels of Lake Victoria (Victoria Nyanza), and of other open waters.

Perhaps I might be permitted to record here that, before the War, I discovered in the Victoria Basin some of these buried surfaces which are rich not only in implements but also in fossil remains. The latter still await specialist identification and study. One day, after the War has ended, a memoir on these and closely allied matters, much overdue and long ago started by Prof. van Riet Lowe and myself, will, we hope, be completed and published. Meanwhile, these Sudan discoveries are most welcome. They are, we may be sure, the forerunners of others no less important; and in this connexion, and with all due deference to Messrs. Andrew and Arkel, I would like to suggest that the terrace deposits and erosion surfaces near Sarsareib, on the Atbara river, might well repay careful study—especially, perhaps, with regard to very early cultures.

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[1] NATURE, 151, 226 (1943).

Production of Potent Toxins by *Shigella dysenteriae* (Shiga) in a Synthetic Medium

ACCORDING to Doerr[1], *Sh. dysenteriæ* fails to produce toxin in a synthetic medium, but regains its toxicity if transferred from the synthetic medium into alkaline broth. Braun and Cahn-Bronner[2] showed that certain dysentery strains can utilize ammonium as source of nitrogen, and that they produce a weak toxin on media containing lactate as source of carbon, and ammonium as source of nitrogen. From a medium with this composition Wichmann[3] produced a toxin with a minimal lethal dose of 1·0–2·0 c.c. on rabbits of about 1,000 gm. weight.

In the experiments described below, *Sh. dysenteriæ*, Bukarest strains (*R* and *S*) kindly provided by Prof. Boivin, were employed. The base medium contained (expressed in percentages) sodium sulphate 0·5, magnesium chloride 0·01, phosphate (KH_2PO_4 0·05 and Na_2HPO_4 0·45), asparagin 0·05, *l*-cystin 0·05, glutamic acid 0·05, tryptophane 0·05, nicotinic acid 0·001, arginin carbonate 0·05 and pyruvic acid 0·5 (*p*H 7·4). Under these conditions the bacteria were capable of excellent growth for more than five generations both at 30° and 37° C. 300–400 millions of bacteria were counted in 1 c.c. within the first days of growth.

At the beginning of growth, acid was produced, but after 3–5 days the reaction turned alkaline. When 0·05 per cent of sodium nitrate was added, the reaction turned alkaline after two days. Addition of 0·1 per cent of glucose enhanced the amount of acid produced and lessened the toxicity. 10 c.c. of the base medium was autoclaved in ordinary size test tubes. For better aeration, the test tubes were maintained during incubation in a nearly horizontal position. After incubation for ten days at 30° C. the bacteria were removed by sharp centrifugation and the clear supernatant fluid left overnight in the ice box after an addition of 0·5 per cent of phenol. On the following day the sterile fluids were injected intravenously into rabbits of 850–950 gm. weight. The results were as follows:

Quantity of toxin injected (c.c.)	*R*-strain		*S*-strain	
	Total number	Died	Total number	Died
1·0	4	4	4	4
0·5	3	2	3	3
0·4	5	2	5	5
0·3	5	3	5	5
0·2	9	3	9	4

The *R*-strain produced only neurotoxin; the *S*-strain produced in addition enterotoxin, as observed by Boivin and Mesrobeanu. It caused a higher mortality.

Gildemeister and Grillo[4] and Takita[5] obtained unusually potent broth toxins when the dysentery bacteria were grown in 'Cellophane' sacks suspended in a large volume of medium. Similar results were obtained with the synthetic medium described above. A 'Cellophane' sac containing 2 c.c. of the medium was suspended in a vessel containing 40 c.c. of the same fluid. After an incubation time of ten days, 30,000–50,000 millions of bacteria were counted in 1 c.c., and the minimal lethal dose was 0·005 c.c. for the *S*- and 0·025 c.c. for the *R*-strain.

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Feb. 3.

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[1] Doerr, R., "Handbuch der Technik und Methodik der Immunitaetsforschung", edited by R. Kraus and C. Levaditi (G. Fischer, Jena, 1908), p. 1,150.

[2] Braun, H., and Cahn-Bronner, C. E., *Biochem. Z.*, **131**, 3 (1922).

[3] Wichmann, F. W., *Arbeiten aus dem Staatsinstitut fuer experimentelle Therapie und dem Georg Speyer Hause zu Frankfurt a.M.*, **21**, 362 (1928).

[4] Gildemeister, E., and Grillo, J., *Zentralbl. f. Bakt., I. Abt., Orig.*, **133**, 201 (1934).

[5] Takita, J., *Kitasato Archiv. Exp. Med.*, **16**, 174 (1939).

Laboratory Synthesis of Diamond

IN 1928 an article entitled "The Problem of the Artificial Production of Diamond" appeared in NATURE[1], in which, after a careful analysis of the existing evidence, the writer stated: "The conclusion seems inevitable that diamonds have not yet been produced in the laboratory, and that investigators have been misled into regarding as diamond various transparent, singly-refracting minerals which happen to be very resistant to chemical reagents".

We have recently examined, by various X-ray methods, twelve minute 'artificial diamonds' prepared by J. B. Hannay[2] in 1879–80, and now in the British Museum (Mineral Department) collection. We find that some are pure diamond, others are diamond plus a small amount of impurity, and only one is not diamond at all. One of the specimens has been photographed using the powerful 5 kW. X-ray tube at the Davy Faraday Laboratory, and it has been conclusively proved that this diamond, at least, is of the rare (type II) variety, which gives only primary diffuse spots and none of the more detailed secondary effects[3]. Not only this crystal, but also several of the other diamonds which were not submitted to such a rigorous X-ray examination, show the highly laminated condition which has been mentioned by Robertson, Fox and Martin as especially typical of type II diamonds. Careful inquiry has convinced us that J. B. Hannay did in fact succeed in synthesizing diamond, although in very small quantity, and we feel that he should receive the long overdue credit for his patience and perseverance in this research. We think also that it is a noteworthy fact that the method he used is capable of producing the rare type of diamond, which only occurs to the extent of perhaps 1 per cent or less among natural diamond single crystals. An account of our investigation is being published elsewhere[4].

It would also, of course, have been most interesting to take X-ray photographs of the crystals which resulted from other attempts to synthesize diamond, particularly those of the late Sir Charles Parsons[5], but we have not been able to trace any of his specimens, in spite of the help given to us by his family and by the firm associated with his name. We would be grateful for any information that might lead to the recovery of these crystals; it would be most unfortunate if they should prove to have disappeared as completely as did the crystals prepared by Prof. Moisson during an earlier investigation of the same kind.

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[1] Nature, **121**, 799 (1928).

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Hydro-Electric Development in Great Britain

The two articles on this subject in Nature of February 13 are welcome for directing attention to the proposals in the Bill presented to Parliament, but the subject requires much more critical attention from the scientific, technological and economic side than it has so far received.

It is surely incorrect to assert that "it is considered beyond controversy that there is only one possible zone . . . and that is in northern Scotland" for siting the electro-chemical and electro-metallurgical industries. We have no vested interest whatever in this question, but have been concerned with it closely, and jointly we have reported rather fully upon it in a series of articles in *Engineering*, May–June 1939. Cheap and abundant electric energy is undoubtedly one of the important factors, but perhaps even more important are favourable location for the transport of raw materials and finished products, and a good supply of labour of the right types.

The inquiry upon which these new proposals are brought forward appears to have been far too limited to weigh up and balance all the important factors involved, and all we now urge is that the scheme should be subjected to more thorough consideration by economists, metallurgists, chemists and both water- and steam-power engineers.

On the face of it, the economics of even the hydro-electric side of the question look to us doubtful (in comparison with steam-power). It is noted that the estimates require the harnessing of seventy individual schemes for developing the relatively small supply of 450,000 kW. and that this demands a national subsidy of £30 million. By comparison, the capital cost of the new Canadian hydro-electric aluminium plant on the Saquenay River, the war-time development of which has just been exposed, is said to amount to only £26½ million for 1,125,000 kW.

We are keenly desirous of fostering the rapid development of the electro-chemical and electro-metallurgical industries in Great Britain, but it is vitally important that they should be established on a sound foundation and not be supported or opposed for reasons which do not concern them.

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Nature of Entropy

The engineer has no difficulty in understanding entropy. The boilerman says: "I give you steam with so much heat energy and entropy, and you want to know how much work your engine will get out of it. I can't tell you as I don't know your condenser, temperature, or how bad your engine is. Multiply your condenser temperature by my entropy and you know how much of the energy is not available in my steam. Your engine will increase entropy by heat conduction, or by wasteful expansion, if a turbine; but that is your look out."

The physics student can get the idea by taking a bottle of highly compressed air. By working a small engine slowly, all at room temperature, he can get a certain amount of work. If he first expands his air into a big vessel, his engine will give much less work. The air in both cases has the same heat content, but the expansion measures its increase of entropy. The increase of entropy means that the heat energy, which remains constant, was made less available by the wasteful expansion.

Forty years ago, I offered the Physical Society a paper on the factors of heat. The factors in the case of a perfect gas, for example, are speed of the nice molecules we had in those days, and their momentum. The paper was refused.

Entropy is inconvenient in being infinite in any quantity of matter (or radiation); so that in integrating you must add a fiducial constant, or be vague.

The conception of entropy is vital in chemistry. The late Lord Rayleigh, in 1875 (or Horstman), laid the foundation of energetics by pointing out that all chemical actions went so as to increase entropy. I do not know which was first, neither did Lord Rayleigh.

J. Swinburne.

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Density of Crabs and Lobsters

Recently the densities of a large male crab, *Cancer pagurus* L., and a large male lobster, *Homarus vulgaris* Milne-Edwards, were found at Plymouth using the *displacement method*, and since—to use a popular phrase—these are the heaviest animals which move freely in sea-water the results may be of general interest. Both specimens were known to be in the late inter-moult stage. The density of the crab with a width of carapace 25 cm. was found to be 1·2784 at a temperature of 8·0° C., which gives a sinking factor of 1243. The density of the lobster 39·5 cm. long was found to be 1·1871 at the same temperature, which gives a sinking factor of 1155. Thus the crab is considerably the denser.

The crab weighed practically 6½ lb., while the lobster weighed about 5½ lb. This is not by any means a record size for either animal, but both were fairly large specimens.

The technique for weighing these large animals is straightforward, but it requires care and preparation. Thus in this particular case it involved the procuring of an accurate balance capable of taking a load of 25 kilos, and a standard flask holding 20 litres. Finally, a density bottle had to be made and standardized, holding 10 litres.

Conditions are too precarious at present to think of carrying out a full investigation of the density of crabs and lobsters, since it would mean keeping a number of specimens of both sexes over a period of four or five years, but from the data already obtained it is possible to make the following generalizations:

(1) The density of the crab is greater than that of the lobster.

(2) The density of the male crab is definitely greater than that of the female.

(3) The density of a large crab is only very slightly greater than that of a small one. (The density of a male crab with a width of carapace of only 6·8 cm. was found to be 1·2648, which compares closely with the specimen given above with a width of carapace of 25 cm. and a density of 1·2784.)

(4) In lobsters the density of the male seldom exceeds that of the female.

(5) The density of a large lobster is considerably greater than that of the smaller.

It is not difficult to account for the differences outlined above when it is remembered that in the lobster the size of the abdomen is comparable to that of the cephalothorax, while in the crab it is greatly reduced, and again a large part of the underside of the abdomen of the lobster is covered with thin chitin only. In the male lobster the claws are greatly enlarged but the abdomen is narrower. Considering the great increase in the size of the claws of the male crab it is not easy to understand the very slight increase in density, since one would look to heterogonic growth to cause a considerable increase.

A. G. Lowndes.

The Laboratory,
Citadel Hill,
Plymouth. Jan. 24.

'White' Bread

Mr. Massingham[1] accuses millers and bakers of producing "faked" bread, basing his charge on the fact that pre-war flour was germ-free. He also states that eighteenth century white bread was never wheat-germless, and that at this period the process of "extraction" had not been invented.

Rich[2] has published figures showing the working of a typical flour mill that operated from 1786 until 1791. Far from "extraction" not having then been invented, "Fine Household Flour" consisted of 55·3 per cent only of the wheat berry, and from this flour was made the white bread then in general consumption in London. Another source from the same period gives 69 per cent for the 'extraction' of this type of flour.

It is probably true, however, that this flour was higher in vitamin B_1 than modern pre-war white flours, as Schultz, Atkin and Frey[3] have found 1·5 I.U./gm. B_1 in 54–62 per cent extraction stone-ground flours, made in as similar a manner as possible to the methods known to be in use a century ago.

The modern roller milling system is the result of much scientific research and produces the type of flour that, rightly or wrongly, people have striven for. When the War ends, the public in Great Britain will most probably demand white bread, as its appearance, eating and keeping properties, in their opinion, outweigh any nutritional advantages that our present bread may have.

A. M. Maiden.

The British Arkady Co., Ltd.,
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[1] Nature, 5, 254 (1943).
[2] *J. Soc. Chem. Ind.*, **60**, 612 (1941).
[3] *Cer. Chem.*, **19**, 529 (1942).

Mechanical Lighters

When about a year ago we found it difficult to get matches I thought of a plan for producing a light especially of value where gas is available, which if brought into use would mean economy in chlorate of potash and elimination of match-sticks and match-boxes—surely a desirable end. But then the definition of a mechanical lighter in the 1928 Act of Parliament was shown to me, which would impose a 2*s*. 6*d*. duty on an article which otherwise could be sold for a penny. I concluded, and the recent Bow Street Police Court tinder box case has shown that I was right, that the Excise would not hesitate to impose the duty on any lighter however advantageous it might be.

My plan was to make a paste of chlorate of potash with so much diluted silicate of soda as would, when dry, make a firm button which could be glued at the end of a rod and used to strike a spark against a safety match-box, or against a sheath coated with the same red phosphorus mixture. Hung up by a gas burner, it would light the gas with the expenditure of perhaps one tenth or one twentieth of the chlorate in a safety match head. To my surprise, I found it would light a methylated spirit lamp the only time I ever tried.

C. V. Boys.

St. Marybourne,
Andover.

RESEARCH ITEMS

Transmission of Leprosy by Ticks

ACCORDING to the *Journal of the American Medical Association* of November 28, Dr. H. Souza Aranjo, of the Oswaldo Cruz Institute, has carried out experiments showing that leprosy can be transmitted by the bite of common ticks. After repeating Max Rudolf's experiment showing that pupæ of *Amblyomma cayennense* show live bacilli in their intestine thirteen days after the last bite of leprosy patients, he described a new experiment with a cattle tick, *Boophilus microplus*, which was fed for a few days on patients in a leprosarium. Seven days after the last meal of blood the intestines of the ticks showed strongly positive acid-fast bacilli.

Vitamin C in the Protozoa

ALTHOUGH the occurrence of vitamin C in the cells of higher plants is well known, the same cannot be said with regard to unicellular organisms, and G. Roskin and O. Nastiukova provide data on the subject (*C.R. Acad. Sci. U.R.S.S.*, 33, No. 8; 1941). No vitamin C has been found in free-living Infusoria, paramecia and Stentor, or in the parasitic Opalina and Nictoterus. When vitamin C was introduced into paramecia with food, it was not stored in the plasma but was liable to disintegration in the digestive vacuoles. On the other hand, vitamin C was found in the protoplasm of *Trypanosoma brucei*, where it was present in the shape of variously distributed granules. Observations on the changes in the quantity of vitamin C during the different stages in the development of infection of guinea pigs by the trypanosome have merely shown that such changes occur but more definite relations could not be established. When guinea pigs were injected with 0·01 per cent ascorbic acid, there was a sharp increase in the vitamin content of their trypanosomes. Thus, the trypanosomes may seriously disturb the vitamin balance of their hosts by consuming vitamins.

Crayfishes of Florida

HORTON H. HOBBS, JUN., has published an important monograph on these freshwater decapods (University of Florida Publications, 3, No. 2; Nov. 1942. Biological Science Series). Its chief value lies in the fact that he has himself collected nearly all the species in the field and gives detailed notes on their habits, habitat and distribution. Apparently the migration of crayfish into and within the State must have taken place largely subsequent to early Pleistocene and is still in progress. The Florida crayfish all belong to the subfamily Cambarinæ in the family Astacidæ, and there are many groups and subgroups showing numerous adaptations to a wide range of ecological conditions. Their natural relationships are described in detail. Forty-two species and subspecies are described, twenty-five of which are, so far as is known, endemic to the State. Among those of greatest interest are some cavernicolous forms. *Troglocambaris maclanei*, a new species belonging to a new genus, is peculiar in living, ventral side up, clinging to the ceilings of wholly submerged portions of underground waterways. The burrowing species are altogether the most numerous. The first pleopods of the male and the shape of the annulus ventralis of the female are the most important organs for taxonomic work. There are many plates illustrating these. Two forms of adult male are recognized, associated with the reproductive cycle. Seasonal data of some of the species are given with records of eggs and young, but there are no descriptions of the young themselves, which presumably, as in all known Astacidæ, cling to the pleopods of their parents by means of the first chela. With so many variations in the parents, one would like to know if the young show any important modifications.

Mammalian Fauna of the Duchesne River

A PAPER on this subject was read by William B. Scott at the autumn general meeting of the American Philosophical Society during November 20–21. The Duchesne River formation has been known for a long time and was supposed to be merely the upper position of the Uinta, in which fossils are exceedingly rare. The Carnegie Museum of Pittsburgh has kept parties in the field collecting fossils from these beds. They have gradually accumulated a remarkable fauna which is of especial interest and importance as being intermediate in time and in character between the Uinta and the White River. The fossils are for the most part very fragmentary, but there are enough excellently preserved specimens to make clear the character of the fauna as a whole. Carnivora are rare and fragmentary, but there is one very interesting specimen which appears to belong to the sabre-tooth cats, and is thus the most ancient American example of this family, or sub-family, which persisted in the Americas until the end of the Pleistocene. The hoofed animals include horses, rhinoceroses, true camels, oreodonts and agriochœrids. These latter families, so characteristic of North America and long extinct, are transitional between Uinta and White River forms. We have also the first of the White River type of brontotheres. The genus Teleodus is common to the White River in its lowest members. Other White River genera are the cursorial rhinoceroses *Hyracodon Hyænodon*. The important feature of the Duchesne River fauna is this transitional character between Upper Eocene and Lower Oligocene.

Cytoplasmic Inclusions in Virus-infected Plants

B. Kassanis and F. M. L. Sheffield (*Ann. Appl. Biol.*, 28, 4, 360; Nov. 1941) report new results from their studies upon the inclusions associated with virus-infected host plants. Striate material, amœboid X-bodies and raphides are the usual inclusions, and these workers have reached the important conclusion that the type of extraneous material formed depends largely upon the amounts of light and heat available to the host. The warm, sunny summer of 1940 brought the appearance of spike-like bodies which had not been seen for some years previously, and several new fibre-like and amorphous forms were also found. All the new types arose either directly or from pre-existing inclusions of the kinds already known. Tobacco mosaic, aucuba mosaic and enation mosaic viruses were used, and it was established that the variation of inclusion bodies was not due to mutation of the virus. A further point substantiating the discovery of inclusions in meristematic cells has been elucidated by Sheffield (*Ann. Appl. Biol.*, 29, 1, 16; Feb. 1942). She has demonstrated the presence of virus in growing points of stem and root by the successful inoculation of specially dissected primordia of tomato and tobacco infected with tobacco mosaic, and tomato with aucuba mosaic. Severe etch virus did not appear to enter the apical meristems of the tomato plant, for inoculation of tobacco with such primordia gave only negative results.

Progress with Indian Fossil Plants

The fossil Azolla is known from material showing both the organization of the plant body and the characteristic reproductive organs. A recent paper describes a new specimen of remarkable beauty ("Indian Silicified Plants—(1) *Azolla intertrappea*", Sahni and H. S. Rao. By B. Sahni, *Proc. Ind. Acad. Sci.*, 14, 489; 1941). It is a megaspore seen in longitudinal section showing the frothy floats round its upper part, while below, the spore wall is covered by filamentous appendages to which a couple of the microspore massulæ are anchored by perfectly preserved hooks. The whole preparation looks as distinct as an ordinary slide of recent material. *A. intertrappea* is considered a typical member of the sub-genus Euazolla, but distinguished from the living species by details of the massula hooks. Its age is probably Eocene, and it is the oldest, as well as most fully known, fossil member of the genus.

Formation of Nicotine in Plants Grafted on Tobacco

Some interesting experiments, throwing some light on the problem of the synthesis of alkaloids in plants, have been carried out by A. Shmuck, A. Smirnov and G. Ilyin (*C.R. Acad. Sci. U.R.S.S.*, 32, No. 5; 1941). When nightshade (*Solanum nigrum*) was grafted on tobacco, the scions developed well, came to flower and formed fruit; the nicotine content of the scions was considerable, though somewhat less than in normal tobacco plants. Tomato plants grafted on tobacco stocks deprived of their leaves developed into large plants, often more vigorous than the control tomato plants, and their nicotine content reached about 0·8 per cent of dry leaves. Even higher nicotine content, 1·5–2·2 per cent, was found in *Datura stramonium* grafted on tobacco stock. When, however, tobacco was grafted on nightshade, tomato or Datura stock, nicotine disappeared entirely from the resulting plant, which otherwise developed normally. The same happened in the case of tobacco grafted on tomato stock. These results show that the formation of nicotine by tobacco depends in some way on the root system and on the stem, and when both these organs are present, nicotine can be synthesized even by plants normally unable to do so.

Effects of Altitude on the Chemical Composition of Cultivated Plants

Experimental sowings of various cultivated plants at altitudes ranging from 1,520 m. to 2,400 m., made by S. O. Grebinsky in the Alma-Ata district of Kazakhstan, produced somewhat unexpected results (*C.R. Acad. Sci. U.R.S.S.*, 32, No. 4; 1941). In the case of sugar beet cultivated at 2,000 m., there was more sucrose and less of the undesirable non-protein nitrogen than in the roots grown at 848 m. In peas, there was an increase in monosaccharides from 1·98 to 3·63, in sucrose from 2·65 to 5·56, and a reduction in ash from 6·77 to 3·45 per cent, when plants grown at 848 m. and 2,000 m. were compared. Tobacco (*Nicotiana rustica*) grown at 2,000 m. had 5·44 per cent nicotine, as compared with 3·58 per cent for tobacco produced at 800 m. Barley has shown a doubling of the average seed weight at high altitudes, while the grains contained less protein and more carbohydrates, which should improve the malting quality. The experiments suggest that many plants do better at higher altitudes, and provide a basis for large-scale tests which may make it possible to utilize high mountainous regions of Middle Asia for agriculture.

Effect of Irradiation on Tradescantia

A comprehensive quantitative analysis has been made of the effect of X-ray and neutron irradiation of chromosomes in microspores of Tradescantia by D. E. Lea and D. G. Catcheside (*J. Genetics*, 44, 216–245; 1942). Several important conclusions are drawn. Whenever a densely ionizing particle such as a proton passes through a chromatid, the latter is broken. A fast electron is unable to break a chromatid except by the tail of the track, which is highly ionized and may cause a break. About seventeen ionizations are necessary to cause a break. Between 40 and 100 per cent of isochromatid breaks (simultaneous breaks in sister chromatids at the same locus) persist in the cell, while only 10–15 per cent of the primary chromatid and 5 per cent of the primary chromosome breaks remain as such. Breaks which rejoin in the original form do so within 3½ minutes. Simultaneous breaks which may rejoin to form interchanges may be 1 μ–2 μ apart. Predictions can be made as to the effect of X-rays of different wave-lengths.

Incompatibility in Solanum

Pushkarnath (*Ind. J. Genet. and Plant Breed.*, 2, 11; 1942) provides convincing evidence of oppositional factors for incompatibility in different species of Solanum which are closely related to the potato. All the diploid species examined were self-incompatible, whereas higher polyploids were self-compatible. Self- and cross-incompatibility in *S. Caldasii*, *S. Chacoense*, and *S. subtilius* is genetically controlled by five allelomorphs. Of the ten possible combinations of these five factors, eight groups have so far been identified and search is being made for the missing S_3S_4 and S_3S_5 groups of individuals.

Shape of Pebbles

When natural pebbles are used as an aid to geological history there is no means of knowing by what stages the individual pebble has reached its present shape. Under experimental conditions the changing shapes of one particular pebble can be examined as attrition proceeds under controlled conditions. Lord Rayleigh reports a series of such experiments (*Roy. Soc. Proc.*, A, 181, 107; 1942). Chalk pebbles, initially shaped as prolate or oblate spheroids, were subject to the abrasive action of steel nuts, nails ('tintacks') and small shot. In general the axes tend to approach equality, but not rapidly enough for the spherical form to be reached before the pebble has disappeared. The form, initially spheroidal, becomes flattened at the poles just like the natural flint pebbles, and may become concave, as flints sometimes do. The abrasion is not merely a function of the local specific curvature, as the figure at other points is involved.

Determination of Half-Value Periods

A new method of determining half-value periods between 10^{-4} sec. and 1 sec., using a single Geiger counter, has been described by A. G. Ward (*Proc. Roy. Soc.*, A, 181, 183; 1942). Using the arrangement the following half-value periods were obtained: actinium A $(1{\cdot}83 \pm 0{\cdot}04) \times 10^{-3}$ sec., thorium A $(1{\cdot}58 \pm 0{\cdot}08) \times 10^{-1}$ sec. and radium C′ $(1{\cdot}48 \pm 0{\cdot}06) \times 10^{-4}$ sec. The work had to be terminated abruptly in April 1940 and the paper has been edited by N. Feather, who gives references to two other papers describing similar circuits developed independently.

THEORY OF DIELECTRIC BREAKDOWN*

By DR. H. FRÖHLICH

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A NUMBER of years ago, a general theory of electronic motion in metals was developed by F. Bloch[1] and others, using the methods of quantum mechanics. Many of the results of this general theory can be applied to non-metals, and we shall see that in ionic crystals a quantitative calculation of the mean free path is possible, which is more than was achieved for metals where one was restricted to an estimate of the order of magnitude. I should like to demonstrate this electron theory of solids by applying it to dielectric breakdown in solids, for which a quantitative understanding has been reached in recent years[2].

The insulation of an ionic crystal breaks down if an electrical field higher than a critical field F is applied. Up to a critical temperature T_0, which is of the order of 100° C., F is a specific property of the dielectric and is called intrinsic electric strength. Above T_0, breakdown usually occurs through thermal instability. We are here interested in intrinsic strength only.

Before the theory described below was developed, von Hippel[3] carried out an experiment which strongly influenced the theoretical development. He showed that the intrinsic electric strength of mixed crystals such as potassium-rubidium chloride is always higher than that of their components. In metals, a similar result is found for the electrical resistance and is known to be due to a decrease of the mean free path[4]. This suggests that the intrinsic electric strength, supposed to be an electronic process, depends on the mean free path of the electrons in a similar way as does the resistance of metals, and furthermore that the velocity of the electrons is in both cases of the same order, corresponding to an energy of several electron volts. This latter conclusion is of importance, because the analogy probably would not apply to electrons with thermal energy.

Let us now consider the mean free path of electrons in ionic crystals. Such crystals are normally insulators, but it is known that in strong fields of the order of 10^6 volts/cm. (but below the breakdown strength), electrons are raised into the conduction band of energy levels. In such strong fields the probability of finding electrons with an energy of several electron volts is very much larger than it would be for a Maxwell distribution[5]. We are, however, not interested in the details of the energy distribution. The mean free path l is connected with the time of relaxation τ by $l = \tau v$, v being the electronic velocity. In the absence of an electric field, the average $\bar{v}$ of v over a time, large compared to τ, vanishes, but $\bar{v} = eF\tau/m$ in a field F, giving rise to a current $i = e\bar{v}$. τ can be calculated from the probability P per second that the electron makes a collision and from the angle of scattering δ by $1/\tau = P(1-\cos\delta)$, thus giving collisions a weight, which increases with δ.

It would be wrong to assume that an electron is scattered by the ions in a similar way as in gases. On the contrary, the most important part of Bloch's general theory states that an electron moves without being scattered through a periodic field of force. Thus in a perfect crystal, neglecting the temperature motion of the ions, an electron is not scattered at all. Scattering is due to the deviations from strict periodicity. In general these may be of two types: deviations due to the temperature motion, and those due to foreign ions (in the case of mixed crystals). Thus the scattering probability is composed of a temperature scattering P_T and a scattering due to foreign ions, P_c, where c represents the concentration of foreign ions. Similarly:

$$\frac{1}{\tau} = \frac{1}{\tau_T} + \frac{1}{\tau_c}\,,\quad \frac{1}{l} = \frac{1}{l_T} + \frac{1}{l_c}.$$

A quantitative calculation of the temperature-dependent mean free path l_T is not difficult. This is due to the fact that the displacement of an ion gives rise to a well-known polarization quite in contrast to the displacement of an atom in a non-polar crystal (or in a metal) where the induced field of force depends on details of the atomic field. The most general displacement of the ions can be developed into a Fourier series, thus giving rise to waves which we shall call polarization waves. If ν is their frequency, their energy U is quantized:

$$U = (n+1/2)h\nu, \quad n = 0, 1, 2, \;.\;.\;.\;.\;,$$

$h\nu/2$ is the so-called zero point energy. The average value of n is, according to Planck's law, given by:

$$\bar{n} = \frac{1}{e^{h\nu/kT}-1}$$

As seems reasonable, the scattering probability P_T depends on u^2, u being the amplitude of the polarization waves. Since $u^2 \sim U$,

$$P_T \sim (\bar{n} + 1/2)\,h\nu = \left(\frac{1}{e^{h\nu/kT}-1} + \tfrac{1}{2}\right) h\nu = \frac{h\nu}{2}\,\phi(T).$$

Besides depending on temperature, l_T also depends on the energy E of the electron ($\sim E^2$). Both P_T and $(1 - \cos\delta)$ decrease with increasing energy. The latter can be deduced in the following way. The scattering of an electron by the polarization waves can be considered as either absorption or emission of a polarization wave quantum $h\nu$. Since we are considering electrons with an energy of several electron volts, the scattering is nearly elastic because $h\nu$ is only about 0·1 eV. On the other hand, the momentum of a wave with wave-length λ is $h/2\pi\lambda$. The shortest waves are of the order of the lattice distance. Their momentum is the same as that of electrons with an energy of about 1 eV. Thus the scattering angle δ is not small. For elastic scattering by waves of a given momentum, $(1 - \cos\delta) \sim 1/E$ follows immediately from the momentum law.

We have thus explained qualitatively the dependence of l_T on T and on E. The exact expression for a crystal of the sodium chloride type is

$$l_T = v\tau_T = \frac{l_0}{\phi(T)},\; l_0 = \frac{16}{2^{2/3}\pi^2}\,\frac{a^2\,E^2}{(\varepsilon-\varepsilon_0)\,e^2h\nu}\,,$$

$$I > E > E_0 = \frac{2^{2/3}h^2}{32ma^2}.$$

ε and ε_0 are the static and the high-frequency dielectric constants, a is the lattice distance. If E is several electron volts, l_T is of the order of 10^{-6} cm., that is, about a hundred lattice distances. Our considerations hold, however, only if E is smaller than I, the smallest energy required to excite or ionize an ion of the lattice. The mean free path for this latter process is only of the order of one lattice distance, so that nearly all electrons with an energy E greater than I will carry out such inelastic collisions.

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* Opening paper of a discussion on "Dielectric Breakdown and other Electronic Processes in Solids" at the meeting of the Electronics Group of the Institute of Physics, held on February 3.

Taking the average over many collisions, the energy

$$A = iF = \frac{e^2F^2\tau}{m} \sim F^2E^{3/2}, \quad E < I$$

is transferred per second from the field to the electron. An equilibrium is possible only if this energy can be transferred from the electrons to the lattice vibrations. Let B be this latter energy per second. B is independent of the temperature because, as for light quanta, the probabilities for emission and absorption of a quantum, $h\nu$, are $1 + n$ and n respectively, so that $B \sim (1-n) + n = 1$ is independent of n, the only quantity dependent on T. The scattering by foreign atoms does not lead to any energy loss (if E is less than I). An exact analysis shows that

$$B \sim \frac{h\nu}{\tau_0}\frac{E}{E_0} \sim \frac{1}{\sqrt{E}}, \quad E < I, \ \tau_0 = \tau_T\,\phi(T).$$

Thus B decreases and A increases with increasing E. Therefore there exists always an energy E' where $A = B$. For $E > E'$, more energy is taken up by an electron from the field than it can transfer to the lattice.

Thus if we omit the restriction $E < I$ in the expressions for A and B, equilibrium would be impossible in the presence of an external field. Considering, however, $E < I$, equilibrium becomes impossible only if E' is less than or equal to I. While B is independent of the field F, A increases proportionally to F^2. Thus E' decreases proportionally to $1/F$. Hence equilibrium is possible for weak fields (E' greater than I), but impossible for strong fields (E' less than I). The critical field where equilibrium begins to become impossible has thus to be determined from $E' = I$. We identify this critical field with the intrinsic electric strength F. From this condition, we find at once that

$$F^2 \sim \frac{1}{\tau\,\tau_0} = \frac{1}{\tau_0}\left(\frac{1}{\tau_T} + \frac{1}{\tau_c}\right).$$

Let $F(T,c)$ be the intrinsic strength at the temperature T and with a concentration c of a given kind of foreign ions. For small c, $1/\tau_c$ is proportional to c and hence $D = \{F^2(T,c) - F^2(T,0)\}/c$ must be independent of c and of T. This result is independent of the exact value of τ, and of details of its calculation. It contains only the fact that $1/\tau = 1/\tau_T + 1/\tau_c$ (as in metals), together with the general condition for breakdown. The result is fairly well confirmed by experiments on sodium chloride crystals with silver chloride as admixture[6], where the experimental value of D is a constant within 50 per cent while $F^2(T,c)$ varies by more than a factor of 10.

The complete theoretical formula for the intrinsic electric strength of pure crystals of the sodium chloride type is

$$F = \frac{\pi^2\,(\varepsilon - \varepsilon_0)\,e(mh)^{1/2}\,\nu^{3/2}}{2^{2/3}\,a\,I}\left(\log\frac{4\sqrt{IE_0}}{h\nu}\right)^{1/2}\phi^{1/2}(T).$$

Without the use of any arbitrary constants, it yields values for F which are in good agreement with the experimental values. A characteristic consequence of the theory is the increase of F with increasing temperature T, due to the factor $\phi(T)$ in the above formula. When this theory was first developed, no experiments on the dependence on temperature of the intrinsic electric strength of ionic crystals were available. On the other hand, experiments on amorphous substances showed a decrease with increasing temperature, and experimental physicists expressed some doubt whether this consequence of the theory could be correct. Subsequent experiments[7,8,9], however, proved this consequence of the theory, at least in a qualitative way.

According to theory, the smaller the frequency ν of the oscillations of the ions the greater should be the increase of intrinsic electric strength. Mica, with its small values for ν, should show scarcely any increase with F, and actually it was found[7] that the experimental value of F at 400° absolute is the same as at 100°. For potassium bromide, on the other hand, the intrinsic electric strength should increase by a factor 2 in the same temperature interval. Various experiments[7,8,9] actually show a large increase by a factor between 2 and 3. At present, however, there is not complete agreement between the various experiments, but all indicate an even larger increase than the theoretical one, although the order of magnitude is correct.

A further consequence of the theory is the dependence of the dielectric strength on thickness. As the thickness of the dielectric approaches the dimensions of the mean free path, the dielectric strength should increase. This effect, too, has been found experimentally with mica[7], where layers of 2×10^{-5} cm. in thickness showed an increase of 50 per cent in the breakdown strength.

In conclusion, it can be said that the intrinsic strength of ionic crystals is well understood. A similar theory should apply to non-polar crystals, although quantitative calculations would be much more difficult. As regards amorphous substances, however, it is not known with certainty whether such an application is admissible.

[1] Bloch, *Z. Phys.*, **52**, 555 (1928).

[2] Fröhlich, *Proc. Roy. Soc.*, A, **160**, 230 (1937); **172**, 94 (1939); **178**, 493 (1941). *Phys. Rev.*, **56**, 349 (1939); **61**, 200 (1942).

[3] von Hippel, *Ergebn. exakt. Naturw.*, **14**, 79 (1935).

[4] Nordheim, *Ann. Phys. Lpz.*, **9**, 607 (1931).

[5] Landau and Kompanejez, *Z. Phys. Soviet Union*, **6**, 163 (1934).

[6] von Hippel, A., and Lee, G. M., *Phys. Rev.*, **59**, 824 (1941).

[7] Austen and Hackett, NATURE, **143**, 637 (1939). Austen and Whitehead, *Proc. Roy. Soc.*, A, **176**, 33 (1940).

[8] Buehl and von Hippel, *Phys. Rev.*, **56**, 941 (1939).

[9] von Hippel and Maurer, *Phys. Rev.*, **59**, 820 (1941).

TRAINING FOR INDUSTRIAL MANAGEMENT

THE paper on part-time courses in education for industrial management presented by H. W. Broadbent at the Conference on Training for Industrial Management, arranged in London by the Institute of Industrial Administration during March 5–7, emphasized that education is a continuous process and demands a review of the whole field if any real meaning is to be given to a planned reconstruction after the War. The minimum age at which any attempt should be made to provide preliminary education for ultimate posts of responsibility is eighteen, and even then the subjects to be included would rightly be described as background subjects. Mr. Broadbent considers that the majority of young people could still be exempted from full-time attendance at school at fifteen or sixteen, so long as they are provided with a carefully planned part-time education on a sandwich system. Normally, such a system should be applied in its integrated form on a weekly basis, where the working hours of the week are divided between education (formal instruction) and training (during their occupation or employment in commerce or industry). Up to the age of eighteen the adolescent should be regarded as a ward of the community, and his welfare, education and training should be supervised and directed by the education department, together with representative bodies of employers and professional institutes, on a regional basis.

Day continuation schools, he urged, offer a great opportunity for experiment and research, but in regard to types of training he merely differentiated between technical (in its widest sense) and administrative training for all executive positions. Up to the 18–19 age-group training during work- or office-time should be strictly vocational, and further development should have as its object the interpretation of experience in the exercise of responsibility, and the crystallization of personality and character. In regard to supervisors, foremen and forewomen, it would be necessary during the transition period to train the supervisors of some years standing in industry. This is a special problem, and Mr. Broadbent suggested that half a day per week devoted to an abridged version of the Institute of Industrial Administration certificate course in foremanship and works supervision, and weekly or fortnightly lectures organized by a staff association, local centre or professional institution would meet the need. For the prospective supervisor, besides the half-day a week devoted to the same course, periods of about three months spent in the various departments of the business or factory were suggested, and promising trainees should be encouraged to continue study in the ordinary certificate course of the Institute.

For the executive groups Mr. Broadbent suggested the two years intermediate and two years final grade course laid down by the Confederation of Management Associations, involving two half-days per week in the first two years and one half-day per week in the second. For the higher executive groups he suggested that the Institute of Industrial Administration should give a lead with regard to lecturers. In addition to regular meetings, where the Case method could be employed, special intensive courses or week-end conferences might be arranged for districts. Executives themselves should be encouraged to lecture and to lead discussions, and selected executives sent to the staff college for specialized training.

Mr. Broadbent also said that he considers that there should be a break of at least a year between the school and university, and if this time was spent in commerce or industry under appropriate conditions, many criticisms of the graduate going down from the university would be met. Towards the end of his course, the graduate should take a special series of lectures covering the administrative field generally and he would then on entering employment come within the scope of the executive courses already discussed. While training in management should not form part of a normal full-time university course, special departments of the universities could with advantage form part of the staff colleges which should be set up in all important centres under the direction of a central staff college, where special sandwich courses would be available for all those recommended to them. A further use of these colleges would be the training of teachers for management and the conduct of research in this field.

Machinery is already in existence which could deal with the regional development of education and training in management, and some of the professional schemes in operation should be incorporated, and the courses indicated should be embodied in national certificate and diploma schemes in industrial administration and management. As consultant body Mr. Broadbent suggested that the British Management Council, with some professional body acting jointly with the Board of Education and the Institute of Industrial Administration, is well qualified to act as central authority for the Council in this matter of examinations. Experience in administration and management should be obtained concurrently with education and training in its broadest sense, and Mr. Broadbent laid down as a general principle that all such training is the responsibility of commercial and industrial firms and should be provided in normal working hours, the cost also being borne by them.

Dr. J. A. Bowie surveyed American developments in industrial management. He urged the importance of Anglo-American understanding in this field. Referring to difficulties in the supply of lecturers and the unsatisfactory results of allowing such lecturers to retain active business connexions—a point on which there was general agreement—he said that the main developments in American business education seem to be a trend away from undue specialization and a return to more general subjects, with less emphasis on detail, routine and technique. Regional specialization in education for management has commenced with a trend towards fewer courses, insistence on better pedagogy, a growing belief that in all matters of business and its teaching the analytical methods of the man of science would alone bear real fruit, increasing distrust of departmental lines, and a growing recognition of the importance of research. The world-wide economic depression has revealed the necessity of providing elementary instruction in economic and general business affairs for all citizens in a democracy, and with the increasing advocacy of business education in Great Britain the lessons of American experience should be of great value.

Mr. A. Sanders surveyed the position in regard to training supervising staff for management. He pointed out that the workmen obtain their conception of the firm's policy from the supervisory staff in the larger works. Including in the term 'supervisory staff' all grades of staff from foremen up to and including departmental heads or superintendents, Mr. Sanders puts character, leadership, co-ordination and co-operation as among the principal requirements in such staff, and their training must include education in the structure of the organization and in the principles of supervision, as well as training and experience in a particular profession or craft.

After discussing briefly the education, training and experience required for various types of supervisory staff, including foremen, departmental superintendents in chemical or metallurgical works, employment and welfare officers, clerical supervisors, and senior cost clerks, Mr. Sanders discussed more particularly education and training in the elements of industrial administration so far as it applies to the supervisory grade of staff. In modern industry it is essential that the staff should have some knowledge of the principles of management, and that changes in organization should be clearly explained to staff if good working is to result. With such training and careful and correct selection of staff, we should not be troubled with the suggestion that a supervisor is born not made.

Commending the Institute's two years course in foremanship, he urged that a more advanced course is desirable for the higher grades of supervisory staff. All supervisory staff should have a minimum training in general principles of administration, production and planning, labour management, and costing and remuneration, and Mr. Sanders referred to the possibilities of a course of internal lectures based on the Institute's full syllabus for the Ministry of Labour course. Such courses should be combined with instruction in the company's own procedure and problems. In many ways foremen present a distinct problem, and are themselves of at least three types requiring varying treatment. Interchange of staff, external conferences, works councils, works magazines can all play an important part in such training, and library provision in any works is essential. Such library facilities should be available for all staff.

Mr. Meigh's paper was concerned with training executives for industrial management. He referred particularly to the increasing need of trained executives and therefore of adequate means of training, paying tribute to the pioneers who have been responsible for noteworthy triumphs of skilful management in British industry. Industrial conditions of to-day, he said, require leadership of a type and in such volume that can only come from systematic training. Such training should follow on a knowledge of the products or processes of manufacture, and he emphasized the value of a broad and liberal outlook on the social functions of industry in attracting candidates for training. For those executives already engaged in industry, the idea of a 'Sabbatical year', visits to similar industrial establishments abroad, contact with other executives in the same industry and participation in the work of manufacturers' associations or federations, joint industrial councils and the like confer a wider outlook and a fresh perspective. Systematic reading of the literature bearing on their work is another means for executives to continue the discipline of education and training; only by the establishment of a high standard of scientific and practical training, based on methods generally agreed after adequate experience, can we hope to enter an industrial era in which management will be universally recognized as a profession. Mr. Meigh submitted a rough outline programme of practical and educational training for junior executives as a basis for discussion.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, March 20

British Psychological Society (at Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Margaret Lowenfeld, Kathleen Todd and Sylvia Payne: "The Methods of Training Child Psychologists at the Institute of Child Psychology".

Saturday, March 20—Sunday, March 21

British Association (Division for the Social and International Relations of Science) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1).—Conference on "Science and the Citizen—the Public Understanding of Science".*

Saturday, March 20

10 a.m.—"The Exposition of Science".
(Chairman: Sir Henry Dale, G.B.E., P.R.S.).
2.15 p.m.—"Radio and the Cinema".
(Chairman: Sir Allan Powell).

Sunday, March 21

10 a.m.—"Science as a Humanity".
(Chairman: Prof. J. L. Myres).
2.15 p.m.—"Science and the Press".
(Chairman: Sir Richard Gregory, Bart., F.R.S.).

Tuesday, March 23

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. J. L. Myres: "Ancient Tripoli and Cyrenaica".

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 3 p.m.—Sir Henry Dale, G.B.E., P.R.S.: "Chemistry in Modern Medicinal Treatment" (ii) "Imitating Nature".

Wednesday, March 24

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. F. Yates: "Agriculture To-day and To-morrow", 7: "Methods and Purposes of Agricultural Surveys".

Thursday, March 25

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 11.30 a.m.—Annual General Meeting; at 2.30 p.m.—"Stereochemistry of Labile Compounds" (Presidential Address).

Union des Ingenieurs et Techniciens de la France Combattante (in the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Lieut. R. Drilhon: "Aperçus sur la Réorganisation rationnelle de l'Agriculture française" (Future of Farming).*

Institution of Electrical Engineers (joint meeting with the Institution of Civil Engineers and the Institution of Mechanical Engineers) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Frank Gill, K.C.M.G.: "Engineering Economics".

Friday, March 26

Association of Applied Biologists (in the Metallurgical Lecture Theatre of the Imperial College of Science and Technology (Royal School of Mines), Prince Consort Road, South Kensington, London, S.W.7), at 11 a.m.—Prof. J. Bayley Butler: "Some Aspects of Applied Biology in Eire".*

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Sir James Jeans, O.M., F.R.S.: "Astronomical Problems of To-day".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. Ezer Griffiths, F.R.S., and Mr. M. J. Hickman: "Modern Heat Insulating and Decking Materials".

Saturday, March 27

Biochemical Society (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 2 p.m.—Annual General Meeting.

Sunday, March 28

South Place Ethical Society (at Conway Hall, Red Lion Square, London, W.C.1), at 11 a.m.—Sir Richard Gregory, Bart., F.R.S.: "Education in World Ethics and Science" (Conway Memorial Lecture).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Engineering in the Batley Technical College and School of Art—The Director of Education, Education Offices, Batley, Yorks. (March 25).

Lecturer in Electrical Engineering—The Principal, County Technical College, Worksop, Notts. (April 3).

Research Assistant—The Secretary, Animal Diseases Research Association, Moredun Institute, Gilmerton, Midlothian (April 26).

Teacher of Engineering (Mechanical) Subjects, and a Teacher (man or woman) of Mathematics—The Principal, Erith Technical College, Belvedere, Kent.

Lecturer in Mechanical Engineering, and a Lecturer in Electrical Engineering—The Clerk to the Governors, Technical College, Chesterfield, Derbyshire.

Assistant Master, with good qualifications in Electrical Engineering, in the Maidstone Technical Institute—The District Secretary, Kent Education Committee, 13 Tonbridge Road, Maidstone, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

From Light to "Heavy". By H. Fox. Pp. 28. (Skegness: C. H. Major and Co., Ltd.) 1*s*. [12

Ministry of Agriculture and Fisheries. Farmers' Income Tax. Pp. 28. (London: H.M. Stationery Office.) 3*d*. net. [42

British Electrical and Allied Industries Research Association. Twenty-second Annual Report, October 1st, 1941, to September 30th, 1942. Pp. 132. (London: British Electrical and Allied Industries Research Association.) [82

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Industrial Chemistry Circular No. 1: Some Technical Aspects of Foundry Cores. By H. A. Stephens. Pp. 19. (Melbourne: Government Printer.) [291

Proceedings of the United States National Museum. Vol. 92, No. 3151: New Neotropical Insects of the Apterygotan Family Japygidae. By H. E. Ewing and Irving Fox. Pp. 291-300+plates 33-34. (Washington, D.C.: Government Printing Office.) [52

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ECONOMIC RECONSTRUCTION

THE report on the domestic economy of the United States, the third in a series prepared by a committee of the editors of *Time*, *Life* and *Fortune*, published in the last-mentioned journal, is striking evidence that American thought is running on similar lines to British thought on reconstruction. This evidence is the more welcome from a source so critical of President Roosevelt's views. Sir William Jowitt in his survey of reconstruction last December reminded the House of Commons that the solution of our problems depends largely on international co-operation. To avert large-scale unemployment of the kind from which we suffered after the War of 1914–18, is a major aim both in Great Britain and in the United States, and was one of the cardinal points made by Mr. Churchill in his historic address on reconstruction broadcast on March 21 (see also p. 359 of this issue).

The Atlantic Charter cannot be made effective without international action designed to raise the standard of life throughout the world, and the Beveridge Report, by insisting on the need for dealing simultaneously with the problem of mass unemployment in order to achieve social security, has given a fresh impetus to the study of the problem, as is evident in the recent statement issued by Unilever Limited and Lever Brothers and in recent articles in the daily Press on planning for full employment. The *Fortune* report facilitates an attempt, independent of the President's pronouncements, to assess the American approach to this problem, and the prospects of the indispensable co-operation on which no doubt Mr. J. G. Winant will be able to report authoritatively when he returns to Great Britain.

The report, it is true, in dealing with the economic system of the United States, ignores the relationship of that system with the rest of the world. None the less, it recognizes that the American system can never, except at outrageous cost, be a closed self-sufficient system, and that America's increasing participation in a unified world should be one of the chief outcomes of the War. That participation will be lame and even harmful to others, if America has not learnt to order her domestic affairs more successfully than in the past, and for this reason the *Fortune* report argues that the first duty of the United States to the world economy of the future is to bring to it an economy that is healthy and free inside itself.

No exception will be taken to that attitude: it is indeed one of the most urgent reasons for the formulation of a social security policy in Great Britain and for Government decision on questions of major reconstruction policy. Moreover, it is of interest to note the parallelism in lines of thought on domestic policy here and in the United States.

Accepting the conclusion that government fiscal policy can and should be used to influence the level of employment, the report proposes that the Government should underwrite permanent prosperity and that it be established government policy, whether Republican or Democratic, to maintain reasonably full employment in the United States. The first and most important step is for the Government to see that private industry, which produces the bulk of goods and services and employs the greater part of the working population, has every chance to operate at capacity and to invest as much of the nation's savings as it can absorb. To-day, government is governing an industrial society, and the condition of private industry must be one of its primary concerns. The second way is to increase individual security by direct means, such as a greatly extended system of unemployment insurance and old age pensions, and greater government responsibility for public health, housing and nutrition.

By maintaining consumer income and effective demand, such a social security programme assists full employment. It sets a minimum standard of purchasing power on which industry can count, and industry is thus enabled to plan its own expansion with more assurance. The third weapon is a flexible programme of public works to be used by the Government whenever and wherever a part of the nation's productive resources is obviously going to waste. Such plans as, for example, urban development, river-valley development or the rationalization of transport, must be prepared well in advance, and it is noteworthy that the *Fortune* report recognizes that while some large public-works projects may appear to compete with private enterprise, on balance, if correctly chosen, they will create far more opportunities for new private enterprise than they destroy for old. This shows a wider vision than some British industrialists in the recent manifesto entitled "A National Policy for Industry".

It is significant that the *Fortune* report does not propose a return to *laisser-faire*. On the contrary, it advocates enlisting the power of government to restore the higher values of individualism, to enthrone the creative, risk-taking, profit-seeking, competitive individual in a sovereign-free market. A more rigorous policing by the Government of the free market is urged to supply the new combination of vigilance and judgment required to keep the market fundamentally free.

There are in this section of the report shrewd comments of exceptional interest on the place of the public utilities, the restraint of monopoly, patent law reform, tariffs and the stimulation of enterprise, which well merit careful consideration in Great Britain. The programme is an attempt at synthesis of the conflicting elements in the immediate past and towards restoring a free market and creative individualism. Its outlook is reflected both in the admirable paper on "The Problem of Unemployment" issued by Unilever, Ltd., and Lever Brothers, and in the recent debate on economic policy in the House of Commons. Sir Kingsley Wood's reference to the importance of Great Britain regaining her technical leadership, paying more and more attention to scientific research and to the steady development of new and more efficient processes, is in striking harmony with the *Fortune* report. Indeed, the final section of that report, on technology and post-war life, is of special interest to scientific workers and touches on some of the important changes at work, such as the chemistry of oil, the development of plastics, the increasing use of light alloys and new processing for foodstuffs.

The Unilever paper shows clearly that there is a similar approach to the problems of post-war economy in Great Britain and that we have leaders who see the difficulties clearly and are equally capable of creative thought. Its comments on planning and on social security are in refreshing contrast to some of the weak criticism of the Beveridge Report. There is nothing to encourage initiative and a sense of responsibility if a man and his family are standing at the end of an unemployment queue, or when he is afraid of unemployment at the end of the week. The minimum benefits of the Beveridge Report are intended to ensure the minimum income which scientific research has established as required, assuming a given price-level, to keep a family in health and vigour.

That position is accepted in the Unilever paper, which concentrates its attention on the means by which such a social security policy is to be achieved. Social security cannot be attained only by legislation fixing minimum wages, unemployment pay and old-age pensions. It can only be solved by an adequate part of the nation's productive capacity being used for the extension of that capacity, leaving a sufficient part available for the production of consumer goods.

Next the paper insists on freedom of choice. The abolition of privilege and the establishment of minimum social conditions do not ask for general uniformity, which would certainly hamper any general improvement of those conditions and the utmost use of the world's possibilities of production. While the profit motive has proved an untrustworthy guide to the extension of productive capacity, the fundamental identity of interest between industry on one hand and the community on the other, whether considered as workers or as consumers, should be remembered. Economic policy should aim at economic development, and freedom from want should be accompanied by freedom from idleness.

There are other observations in the paper on the function of government and that of private enterprise which should be noted. Industry's rôle is to endeavour to produce as cheaply and efficiently as possible, but it should show its sense of social responsibility, for example, in planning for development with as long a view as feasible, adopting a scheme of guaranteed earnings and training during interrupted employment, widening the possibilities of advancement to higher responsibilities, improving the contacts and mutual understanding between management and workers. Industry, voluntarily organized, should help government to the full, facilitating contact between them for furthering the government's economy policy and providing government with accurate and up-to-date information on production and marketing. Modern methods of market research should be developed to enlighten both government and industry on changes in the trend of economic life. Collaboration on these, leaving to government and industry each its own work in its own field, and not the direction of industry by a reorganized Civil Service or the delegation to industry of part of the duty of government, will ensure a regular and progressive development of economic life. Similarly, the responsibility for the social well-being of the population which obliges governments to take a guiding part in framing economic life makes it incumbent on government to safeguard economic policy from those influences that would make it haphazard or failing in international spirit.

The general similarity in outlook of the two documents is clear from what has already been said, but the Unilever paper is much more specific in its conclusions and proposals. The thesis that the main task in fostering regular capital investment and through it regular employment lies with the central government, leads to proposals not for direct government control over production but for the exercise by government of the powerful means of indirect control it possesses. The chief proposal to co-ordinate these influences on a systematic plan for dealing with the trade-cycle is the system of two budgets—an ordinary budget balanced annually for meeting standing expenditure out of current income, and an extraordinary budget to meet normal capital expenditure and such emergency measures as should be taken in times of depression to fight unemployment or stimulate trade. This extraordinary budget would be covered or over-covered only in times of prosperity.

Provided it is used solely for the purpose of regularizing economic life, the two-budget system is claimed to be the most efficacious means of controlling the trade-cycle and is the one that needs most study; this study should be undertaken now. No progression of productive activity, however, can be kept regular that leaves no reserve available in man-power or machines. A part of the working population will, under conditions of normal industrial activity, always be temporarily unemployed. They should not be without sufficient income, nor should they be idle, and the fluctuations of this labour reserve, in both numbers and the way it is made up, will be the signal to the government to apply its anti-boom or anti-slump measures, all of which should be planned well in advance.

In addition to the general monetary and budgetary measures suggested for the checking of a boom or a slump, supplementary special measures are suggested, such as public works of a special kind, as distinguished from normal government capital expenditure; the special training of younger people who cannot find a job; re-training of workpeople whose unemployment is due to structural, local or seasonal causes; and occupation in temporary work such as afforestation, and preparing uncultivated ground for tillage or pasture. It is assumed that, in addition to these measures to be applied intermittently as required, government and industry will apply continuously measures for achieving social security, and a number of specific industrial measures are suggested, including the planning of development with as long a view as possible, voluntary schemes for training workpeople for other work and for guaranteeing earnings during sickness, accident, short-time, or unemployment that is temporary only, and the institution of works councils or similar bodies.

Any wide plan for social security in one country, however well devised, is at the mercy of events in other countries, and it is of vital importance to the success of any such scheme that similar measures are taken in all major industrial countries. The necessary contacts in the field of commercial policy and of social security, which in the international monetary field have been a conspicuous success, would, it is suggested, be best obtained through international councils or similar institutions having permanent international secretariats on which the governments of the various countries would be permanently represented. These organizations would negotiate, conclude and expedite international agreements on such matters as the adaptation of productive capacity dislocated by the War to allow the various countries to produce and consume according to their abilities; positive measures for encouraging the expansion of international trade; the protection of countries that embark on anti-unemployment measures and plans for social security against unfair competition from other countries; regulation of the production of stocks and prices of raw materials; and raising the standard of living in undeveloped countries.

Schemes so comprehensive as the Beveridge plan and that of Unilever Ltd. and Lever Brothers assume the existence in the world of a strong consciousness of the fundamental community of interests that binds all classes of society and all nations, for their success depends on the existence of similar schemes in the principal industrial countries. Moreover, much has to be learned from experience, and the technique required for their handling will only be developed gradually. Such conditions demand not only courage in the conception of schemes but also foresight to protect society against partial failure. It is a hopeful sign that the challenge of the Beveridge Report has been taken up so unhesitatingly in the United States.

The references to the Unilever paper in the debate in the House of Commons on economic policy indicate that its proposals are already receiving serious consideration and have attracted widespread attention. Sir Kingsley Wood's speech, like that of Mr. Dalton, showed that constructive lines of policy at home are being mapped out.

Much that the Chancellor said needs to be kept in mind in considering the Beveridge Report and other schemes for reconstruction and the transfer of our resources as quickly as possible back to peace-time purposes, to promote employment and to revive export. He insisted, for example, that we would need to maintain, in any event for a time, a considerable measure of control of our economic life. It might also be desirable to continue the policy of the stabilization of the cost of living and the prices of goods in common use along our present lines. Controls relating to the demand for scarce materials or manufacturing capacity would require careful co-ordination with such a stabilization policy. The control of the release of raw materials and of issues of capital might also continue to be necessary.

Certain of the proposals outlined by Sir Kingsley Wood indicate that proposals in the Unilever paper are very much in line with the mind of the Government. The Chancellor stressed the great contribution which the Government could make by its general policy in foreign affairs, by its interest in the promotion of export trade, by its internal financial policy and the economic development of general social policy. The Government could also stimulate directly the provision of capital equipment, and the Chancellor referred specifically to the effect of a well-considered building programme planned several years ahead. Besides the restoration of trade and business and active employment, he stressed the importance of an adequate defence programme for international security to prevent a repetition of the present disaster, and his reference to the Government's intention to see that up-to-date statistical information should be available to the maximum extent after the War will be particularly welcome to those scientific workers who are aware not only of the importance of adequate knowledge of economic facts and tendencies for reasonable direction of our economic activities, but also of the backwardness of Great Britain in the collection and publication of economic and financial statistics—a statement clearly intended to remedy a defect to which Mr. Herbert Morrison directed attention recently.

The Chancellor closed his speech with an important statement as to the main directions in which it was generally agreed we could advance. First, he said, we shall need a policy of expansion so that employment is maintained and production serves the end of consumption, coupled with an expansion in international trade and the orderly reduction of unnecessary barriers and other practices interfering with the flow of goods from one country to another. Secondly, we shall need a strong effort to prevent disastrous swings in the prices of the raw materials and primary products of the world. Thirdly, we shall need an international monetary mechanism which will serve the requirements of international trade and avoid any need for unilateral action in competitive exchange depreciation. Fourthly, the work of the International Labour Office, with its interest in the standard of working conditions in all countries, has a great bearing on the orderly development of international trade; and, fifthly, when the world begins to settle down and each country has a clearer picture of its own resources, we shall need some international organization for assisting the direction of international investments for development.

Replying on the debate on February 3, the President of the Board of Trade stated that he has recently made arrangements for an intensified study of post-war problems, and after the consultations which are proceeding with national bodies and particular interests he hoped to be able to draw up a plan embodying points which are common ground, and to pursue closer study of the national plan. He reiterated the Government's intention to attack the problem of mass unemployment and to seek to bring about an expansion in international trade by international agreement. We need also an expansion in the home market and in the standards of production and consumption among our own people.

Mr. Dalton's insistence on expansion rather than restriction—expansion but not inflation—stability of prices but not stagnation, order in our schemes but not undue rigidity, is the more important as passages in his speech lend colour to the belief that the Government countenances the restrictive policies advocated by some of the reconstruction schemes put forward by the trade associations. That is indeed one of the great dangers. The emphasis must be on expansion, and all restrictions on trade and industry which do not contribute to the national purpose and serve merely sectional ends must be set firmly on one side. The dangers of such restrictive policies are clearly recognized in the *Fortune* report as well as in the Unilever paper, but such policies are firmly embedded in some of the reports issued by bodies with which Mr. Dalton stated that he has been consulting.

This is one of the reasons why it is imperative that the Government should announce its plans and policy in greater detail. A central plan is essential if a firm hand is to be taken with the sectionalism and the ideas of restriction which are still current in some quarters. An energetic and coherent policy framed to meet the new conditions which the Government clearly has in mind, and recognizing a broadly conceived national interest which stands above considerations of individual or sectional profit or privilege, is as essential to Anglo-American understanding and co-operation as it is in fortifying the nation for the supreme effort to which it is now being called in the present struggle. Furthermore, it is the first step to the formulation of a policy for the re-organization or reconstruction of world trade—a matter in which, though its importance was recognized in the debate, the Government spokesmen did little to dispel confusion and anxiety. Without a firm break from those policies of restricted consumption and hence of restricted production and mass unemployment which led the world into chaos and to war, we have no hope of securing the whole-hearted co-operation of the United States or the other United Nations in the attack on this fundamental problem.

Consumption is the only effective starting point of a programme of expansion, and by making full employment and rising standards of living the effective aim of domestic policy and neglecting no steps calculated to achieve them, Great Britain could enter the councils of the United Nations with the promise of an expanding British market for foreign as well as for domestic production on the sole condition that the means of payment in British exports be not denied to her. There can no longer be doubt as to the support which would be forthcoming in Great Britain for such a policy which would place the initiative in British hands. The close parallel between the speeches of British and American statesmen, no less than the trend of the *Fortune* report, justify the belief that the United States and others of the United Nations would not lightly refuse the wholehearted co-operation which would ensure the success of such a policy, with its benefits, not to one country alone, but to the whole post-war world.

EVOLUTION IN ACTION

Systematics and the Origin of Species: from the Viewpoint of a Zoologist

By Ernst Mayr. (Columbia Biological Series, No. 13.) Pp. xiv+334. (New York: Columbia University Press; London: Oxford University Press, 1942.) 27*s*. net.

DURING the last decade taxonomy has not merely experienced a revival but has also become one of the active growing points of biology. It is the focus round which genetics, ecology, field natural history and other biological disciplines have concentrated to illuminate the study of evolution in action.

Until now, the comprehensive studies in this new joint field have been undertaken by general biologists—preponderatingly, as in the compilation entitled "The New Systematics", or solely, as in the recent books by Haldane, Waddington or myself; or geneticists, as in Dobzhansky's interesting "Genetics and the Origin of Species", now in its second edition. The only exceptions to this have been the studies of the German systematist Rensch, but these were largely in the nature of pioneer work.

Now at last Dr. Mayr has approached the problem from the other side of the fence, from that of the practising systematist, familiar with the most modern taxonomic methods, but also in close touch with some of the world's leading geneticists.

This is the first work on 'evolution in action' to be written by a specialist in the taxonomy of a single major group of animals. What is more, it is improbable that anyone save a specialist in the systematics of birds could have written such a satisfactory work; for, as Dr. Mayr points out, the class Aves is better known systematically than any other group above the rank of sub-order, and general taxonomic principles of various sorts only emerge clearly from the comparative survey of well analysed material.

The result is a book of high value for the taxonomist, for the geneticist, and for the general biologist and the student of evolution. The degree of intensive study which the avian systematist has been able to give to his study, thanks to the relatively small number of species in the group, and the thorough collecting that has gone on in all parts of the world, has enabled him to perfect taxonomic methods and to draw general conclusions to an extent which has scarcely been attempted in most groups. Mayr estimates that less than 2 per cent of the total number of bird species in existence remain to be discovered. Of those which have been described the great majority are known from long series, which enable us to pronounce with considerable accuracy as to their infraspecific constitution; we know what a bird subspecies is, we know how subspecific and specific differentiation proceed in different circumstances and in different regions.

The geneticist is presented with a vast array of natural experiments which provide material of the greatest value for his theoretical or experimental analysis. The general biologist is given a fascinating picture (which much extends the basic outline already provided by palæontology) of how evolution actually works, how it is related to the geographical environment, to violent climatic changes like those of the Ice Age, and to the peculiarities of the evolving stock and the biological competition to which it is exposed.

Space will not permit mention of more than a few of the main conclusions. Perhaps most important, Mayr has given convincing reasons (certainly they have convinced me to change my views in the matter) that in higher animals all speciation, except the small fraction which begins by the differentiation of true 'biological races' in parasites, parasitoids, and monophagous food specialists, depends in the first instance on geographical isolation; ecological and genetical differentiation can never bring about the requisite degree of isolation between groups, though they can accelerate and amplify the process of divergence, once it has been initiated (and to an extent which is perhaps a little under-estimated by Mayr).

In clearing up this position, Mayr has a valuable section on "sibling species", a purely descriptive term which he introduces for closely related forms with overlapping geographical ranges, which must be classed as species because they exhibit complete reproductive isolation, but which are so similar in appearance that the systematist brought up in morphological methods is reluctant to separate them taxonomically. Under this head he puts the well-known case of the so-called "biological races" of the malaria mosquito, the puzzling cases in ants which myrmecologists usually call "varieties" or "subspecies", and various birds, of which the cave-swifts, the minivets, and the babblers provide some striking examples, which have deceived all systematists until very recent times.

This phenomenon would seem to demand a good deal more analysis. Mayr tends to dismiss it as "not surprising", once one has rid oneself of morphological preconceptions. The fact remains that most speciation, even in animals of "non-optical" groups, does involve considerable morphological (visible) divergence; and sometimes, as where distinctive form and pattern provide the basis for preventing species-crossing, we can understand why such visible divergence should be striking. The fact that sibling species are in a small minority, but that they exist even in "optical" groups like birds, demands explanation.

Then Mayr emphasizes the need for studying speciation in all types of regions before drawing general conclusions about the process. He gives quantitative evidence that whereas the majority of species in old tropical archipelagoes are in the later stages of the speciation process, the reverse is the case in continental areas, especially those where large-range changes have recently occurred, as in the north temperate zone since the close of the Glacial period. He writes: "so far as I know, all workers who minimize the importance of geographic formation for species formation base their opinion on work done in the Holarctic region. On the other hand, von Buch, Darwin, Wallace and others derived their clear ideas on evolution from a study of both continental and insular species".

As might be expected, the author has something of value to say on taxonomic categories. The genus, for example, is "based on a natural phenomenon", namely, the fact that species are not evenly distinct from each other, but diverge so as to form smaller or larger groups, separated by smaller or larger gaps. But genera do not have "objective reality", because, unlike species, they do not constitute groups with definable limits—in other words, it is an arbitrary matter whether we make our genera large or small, whereas the definition of the size and limits of a species is in principle never arbitrary, though there may be borderline cases. The size of a genus is, therefore, a matter of practical convenience, and Mayr enters a cogent plea against the retention of "giant" genera, and still more against the undue creation of monotypic genera.

We should also mention that Mayr gives what would appear to be a definitive refutation of Goldschmidt's heterodox views on speciation.

Among the few points of criticism to be made are Mayr's curious neglect (though this is in common with many other evolutionists) of the organic selection principle of Baldwin and Lloyd-Morgan, which deserves the most careful consideration as an auxiliary method of evolution. Another is his failure to give full consideration to the case of groups of subspecies inhabiting large continental areas, and with zones of intergradation at the margins of their ranges. He appears (if I understand him aright) to consider that all such subspecies are likely to differentiate into full species with time, owing to the introduction of geographical, climatic, or biological discontinuities. However, the alternative thesis may be maintained that partial discontinuity of this sort may in such areas constitute an equilibrium phase in the speciation process, and that such groups of subspecies may, therefore, continue to maintain themselves and to evolve without further increase of taxonomic divergence. It would be of extreme interest to be given a discussion of this problem by someone like Mayr, who is familiar with the taxonomic data. However, as I have already said, Mayr's book invites few criticisms and much gratitude. It is a distinctive and valuable contribution to modern evolutionary studies. Julian Huxley.

THE PHYSICAL BASIS OF MEDICAL RADIOLOGY

Radiologic Physics

By Charles Weyl, S. Reid Warren, Jr., and Dallett B. O'Neill. Pp. xvii+459. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1941.) 5.50 dollars.

THE period between the War of 1914–18 and the present War has been marked by outstanding advances in every branch of scientific, medical and industrial radiology. At the beginning of this era, the induction coil was probably the most favoured apparatus for the production of the high potentials required to excite an X-ray tube; the Coolidge tube had just been invented; the measurement of radiation for biological purposes was in a chaotic condition, since there were neither agreed units nor standards of measurement; and hospital X-ray departments were frequently located in ill-ventilated basements or other inaccessible parts of buildings, in which devices for the protection of the operating personnel against the injurious effects of scattered and direct radiation and high-tension discharge were in the majority of cases either non-existent or utterly inadequate.

The situation to-day is vastly different from this. The induction coil has been almost entirely supplanted in X-ray sets by transformer-plus-rectifier units which, together with elaborate controlling mechanisms, ensure a constancy and reproducibility of output in intensity and duration previously unobtainable. Thanks to the pioneer work of Sir William Bragg and the labours of standardizing laboratories in many countries, ionization instruments have been developed which enable medical radiologists throughout the world to administer identical prescribed doses of X-rays to their patients. At the same time, the problems of protection have been so thoroughly explored that we may confidently anticipate there will be no more X-ray martyrs. The recent discoveries in the field of nuclear physics and the contemporary development of apparatus capable of producing current at pressures of millions of volts foreshadow further great advances in the treatment of disease by means of X-rays and radioactive substances. Recently, Dr. Coolidge has stated that the fortieth *portable* million-volt X-ray generator was being completed in the G.E.C. works at Schenectady. Further, he announced that the promising results of tests carried out with an X-ray generator based on the "betatron" principle and functioning at 20 million volts have encouraged his Company to build a larger model on the same principle designed to operate at 100 million volts.

Diplomas in medical radiology have been instituted by universities and other examining bodies in Great Britain and other countries, and the training of candidates for these now forms one of the regular post-graduate courses of instruction. Against the background of continuous scientific and technical progress increasing demands are made on the knowledge of physics and electro-technics possessed by the candidates. Not only must they be familiar with the construction and mode of action of the complicated apparatus they employ, but also they must be equipped to appreciate fully and take advantage of future discoveries and developments useful in their speciality.

The present book has been written with this dual object in view, and embodies a course of instruction which the authors have given for several years in the department of radiology of the Hospital of the University of Pennsylvania. It can at once be said that the book fulfils its purpose admirably and is probably the best of its kind available in the English language. Beginning with the fundamental physical principles of electricity and magnetism including electronics, the authors then describe the construction and mode of action of measuring instruments, transformers, generators, motors, rectifiers and electromedical apparatus. Succeeding chapters discuss radiant energy and its interactions with matter. Those physical properties of X-rays and radioactive substances useful for diagnosis or medical treatment are explained both adequately and lucidly. Special chapters deal with the measurement and control of X-rays and of gamma-rays for therapy, and with the physical aspects of X-ray fluoroscopic and diagnostic techniques.

In a book of uniformly high standard, we would select for especial commendation the chapters dealing with the physical principles underlying diagnostic radiology—a subject much neglected in other textbooks in English. The book is well produced and appears to be free from misprints and errors. The description of electrons, neutrons, protons, etc., as "atomic" entities (p. 254) is perhaps scarcely justifiable, and some American words sound strange to English readers; for example, "retention" for "persistence" of vision (p. 154), "laminagraphy" for "tomography", etc. One misses, too, any reference in the text to the names of people associated with some outstanding contributions to the subject, such as Bouwers, Coolidge, Greinacher, Rutherford, Villard; although in general full justice is done to the subject-matter of their contributions. The inclusion of a description and diagram of a *mechanical* rectifier (pp. 183, 184) is somewhat surprising. The authors have shown great skill in the selection and discussion of the matter included in the book. They have met in advance any possible objection which might be raised to the restricted treatment or rejection of any topic by including a good bibliography of references. The book should be found in all radiological libraries, and is certain to achieve a well-deserved popularity among medical students and those who desire to become qualified radiologists, whether medical or industrial.

F. L. HOPWOOD.

ELECTRIC POWER CONTROL

Electric Power System Control

By H. P. Young. (Monographs on Electrical Engineering, Vol. 11.) Pp. xii+319+22 plates. (London: Chapman and Hall, Ltd., 1942.) 25*s.* net.

JUST as ordered control is the keynote of success of the individual and of the organization, so is it when applied to the harnessing of the forces of Nature, either in their pristine state or as manifested in the workings of man-made mechanisms. In the electrical field of endeavour, intelligent control is a vital necessity, and it finds its highest expression in the various forms of automatic apparatus and systems which are so largely responsible for the modern reliability of electric power supply. It is no exaggeration to say that the extensive interconnected high-voltage power systems of to-day with their hundreds of thousands of rated kilowatts and millions of potential fault kilowatts owe their operational success and, indeed, their very being, to automatic control and protection. A book such as this, which brings the subject before the reader as a co-ordinated whole, is, therefore, a valuable addition to electrical engineering literature and is welcome accordingly.

The opening chapter is of an introductory nature and discusses the parallel operation of generators and the characteristics of exciters. Two chapters follow, on the automatic regulation of both voltage and power factor of synchronous machines, stress being laid upon the importance of the subject from the point of view of system stability. The succeeding chapter is devoted to the synchronizing of alternators, an operation which it is essential should be carried out accurately to avoid high-magnitude current surges.

Power control by reactance is a technique which has been adopted for many years on large systems in respect of machines, busbars and feeders, and Chapter 5 describes the principles and application of the different methods and apparatus. Chapters 6 and 7 deal with circuit breakers, circuit interruption, power station switchgear arrangements, and short-circuit calculations, and they form a reliable guide to modern practice and developments in these important branches of power control.

The last three chapters relate respectively to the interconnexion of power stations, interconnector control, and automatic supervisory control. These are all features of power system operation which are rather imperfectly understood by most engineers apart from the control specialists and hence are valuable additions to the book.

It would be easy to suggest additional studies which the author might have included, but nothing which might have been omitted. Within the confines which have been laid down, the book is an eminently suitable guide to electrical engineers interested in both the design and operation of power system networks.

ENGINEERING DATA

The Engineer's Year-Book of Formulæ, Rules, Tables, Data and Memoranda for 1943

A Compendium of the Modern Practice of Civil, Mechanical, Electrical, Marine, Gas, Aero, Mine and Metallurgical Engineering. Originally compiled by H. R. Kempe and W. Hanneford-Smith. 49th annual issue, revised under the direction of L. St. L. Pendred. Pp. xii+2854+lxxxi. (London: Morgan Brothers (Publishers), Ltd., 1943.) 40*s.* net.

DESPITE the difficulties associated with war conditions, "Kempe" has once more appeared in a new edition—the forty-ninth—and, certainly as regards its external appearance and form, is but little different from its more recent predecessors. Internally, too, there is little change from last year's issue, which was made the occasion of one of those periodical revisions by which from time to time it renews its youth.

In the present issue, then, one would expect to find a number of minor corrections rather than any alterations in the body of the work. As it happens, however, very little correction proved to be necessary, and the principal change is found in the sub-section devoted to fire extinction and prevention, which has been revised and amplified by Hubert B. Graham, president of the Fire Extinguisher Trades Association. This forms Part IV of Section XXXVI and, in the space available, deals in considerable detail, though necessarily succinctly, with first-aid precautions and appliances, mobile secondary-aid and major appliances, fixed installations, fire hose, pressures to give various ranges of fire streams with different sizes of nozzle, fire-resisting buildings and materials, fire prevention at sea and oil fires. The collated information regarding the different types of extincteurs, their charges, their capacity and their applications should prove most valuable.

It is difficult to present the scope of "Kempe" to anyone who has not handled the book itself in recent years. The bibliography shows a number of 'continents' into which its world can be divided, but in each of these there are major and minor subdivisions almost beyond enumeration or description. Its 2,751 pages, exclusive of the index, which occupies 72 pages—a fact which, in itself, is illuminating as to the variety of items dealt with—are allocated to no fewer than forty-seven main sections. These are very largely devoted to the practical side of engineering, and include such representative titles as surveying, reinforced concrete, aircraft and aero-engines, radio communication and electric traction, to name but a few. In contrast with these a fair proportion deal with more fundamental subjects such as mechanics, heat, and acoustics. A third group includes those giving information on patents, designs and trade marks, depreciation of plant and machinery, income tax allowances, and legal notes for engineers. Thus it can be seen that "Kempe" is eminently a book for every engineer's desk, and one capable of informing him on many points requiring confirmation or elucidation.

SIR WILLIAM CHANDLER ROBERTS-AUSTEN*

By DR. S. W. SMITH, C.B.E.

IT is now more than forty years since Roberts-Austen was a familiar figure at scientific and technological gatherings. Born on March 3, 1843, in Kennington, his whole life coincided with a period of intense scientific and metallurgical activity, and, living as he did in the Metropolis, and for the greater part of that time at the Royal Mint (where he died on November 22, 1902), he had exceptional opportunities of participating in the proceedings of the numerous scientific and technical societies having their headquarters in London, and of being closely associated with those who were concerned with their various activities.

The name by which he is known was added in middle life for family reasons, when, as William Chandler Roberts, he was granted license to add the name of Austen. It is this name which has been perpetuated by the distinguished French metallurgist, Floris Osmond, who dedicated to him the discovery of the constituent of steel to which he gave the name 'austenite', and which, with its derivative 'austenitic', have become terms in daily use.

Early Influences

It is of interest, I think, that we should take a glance at the background of Roberts-Austen's earlier professional career and consider for a moment the extent to which his bent for scientific investigation was influenced by those with whom he became associated and under whose inspiring influence his aspirations were no doubt stimulated. Of these I would mention two to whom he paid generous tributes in later years.

First of all, Dr. John Percy, professor at the Royal School of Mines—then at Jermyn Street, London. Roberts-Austen entered in 1861, at the age of eighteen, with the intention of pursuing mining as a career; it was undoubtedly due to Percy that his interests were deflected to metallurgy.

Having completed the course at the School of Mines, Roberts-Austen, no doubt on the recommendation of Percy, went to the Royal Mint in 1865 as personal assistant to Thomas Graham, and for four years—that is, until Graham's death in 1869—continued to assist him in his private laboratory at the Mint, but in no direct way associated with the operations of coinage. During this time Graham was pursuing his researches on the diffusion of gases in metals and, in particular, the classical work on the occlusion of hydrogen by palladium, in which Roberts-Austen felt justifiable pride in having participated.

At the death of Graham, the office and title of 'Master of the Mint' was in future to be held, *ex officio*, by the Chancellor of the Exchequer, while the actual administration of the Department was entrusted to a 'Deputy Master and Comptroller'. Roberts-Austen was retained in an official capacity as 'Chemist to the Mint' and was entrusted with the responsibility, as an assayer, and still occupying Graham's laboratory, of ascertaining and certifying the legal composition of all standardized alloys and finished coins.

A further reorganization of the work of the Assay Department occurred in 1882 on the retirement of Mr. E. L. J. Ridsdale, the officer responsible for the valuation of all gold and silver bullion imported into the Mint. Roberts-Austen was given full charge of the valuation of bullion at all stages with the title of 'Chemist and Assayer of the Mint'. This office he continued to hold, never releasing himself from a share in the daily responsibilities of routine work, until, on the death of the then Deputy Master (Sir Horace Seymour), early in 1902, he was called upon to add the duties of that office to those of his own.

Early Work at the Mint

The earlier years of Roberts-Austen's official career were devoted almost exclusively to matters directly related to the operations of minting, and the thoroughness with which he explored the historical records of the art is shown by the admirable series of Cantor Lectures which he delivered before the Royal Society of Arts in 1884, on "Alloys Used for Coinage".

One is tempted to dwell longer on the variety of interests which Roberts-Austen found to attract his attention in those earlier years, such, for example, as the repetition of some of Spring's work, of 1878 and 1880, on the compression of metallic powders, which we now call 'powder metallurgy'; but one must keep steadily in mind the lines along which he developed his main contributions to metallurgical progress. An important milestone is, undoubtedly, a remarkable paper which he contributed to the *Proceedings of the Royal Society* so early as 1875, "On the Liquation, Fusibility, and Density of Certain Alloys of Silver and Copper".

Roberts-Austen set himself the task of determining, in the first place, the temperatures at which the alloys of these metals solidify when the composition ranges from pure silver to pure copper. At that time the only course open to him was to adopt a laborious calorimetric method of temperature measurement based on a modification of a procedure employed by Pouillet in determining the specific heat of platinum at high temperatures. The fifty or so observations of freezing points were plotted graphically and constitute the first recorded 'freezing-point curve' of a series of alloys which solidify beyond the range of the glass thermometer.

Although Roberts-Austen's original intention in undertaking this work was to find an explanation of the segregation which occurs when alloys of the precious metals solidify from the molten state, a behaviour which, following the train of thought which he had inherited from Graham, he spoke of as "molecular mobility", the actual outcome of this work was the direction it gave to a search for more accurate methods of measuring and recording high temperatures and to the means which these would afford of studying the constitution of other series of alloys. From then onwards for many years he sought to make available a means of recording autographically those changes in the rates of heating and cooling of metals and alloys which accompany changes of phase below and above their melting points. For this purpose he followed the lines which had been initiated by Henri Le Chatelier, who had shown the possibilities of making use of thermo-couples of platinum and platinum-rhodium for this purpose.

The recording pyrometer continued to be his chief implement of research until he adopted the methods of photomicrography in 1895, which became complementary to it. He made effective use of these two lines of approach in revealing the molecular changes taking place in metals and alloys and in demonstrating the reality of those changes by photographic means. Demonstration was, in fact, one of his most useful attributes at a time when there were few opportunities for those immersed in engineering and productive work of becoming even acquainted with the trend which physical metallurgy was beginning to take.

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* Substance of the centenary address arranged by the Institution of Mechanical Engineers, the Iron and Steel Institute and the Institute of Metals, delivered on March 3.

Much of his earlier work at the Mint arose directly from problems presented by his official duties. From the difficulties in dealing with 'brittle gold' caused by the presence of traces of impurities, he passed, in time, to the consideration of the effects of traces of elements deliberately added both to ferrous and to non-ferrous metals.

From the difficulty in securing uniformity in the official standards of reference of the gold and silver coinages he passed to the determination of the molecular changes occurring during the passage of molten alloys to room temperatures. The need for the provision of better steel for the manufacture of coinage dies led to a closer study of the iron-carbon alloys, while the preparation of electro-deposited reproductions of plaster models furnished him with the means of studying the molecular transformations in pure iron. The 'flashing' or 'recalescence' of the cupelled buttons of gold and silver during the daily operations of assaying gold bullion led him to make an extended examination of the 'undercooling' or 'surfusion' of alloys.

These examples of his early work at the Mint are sufficient, I think, to show how he was led, from what one might regard as parochial matters, to extend his inquiries to wider fields and to matters of fundamental scientific and metallurgical importance.

The Royal School of Mines

Fifteen years elapsed from the time Roberts-Austen left the School of Mines in 1865 until he again became directly associated with it in 1880 as the professor of metallurgy at South Kensington. His outstanding contribution to the teaching of his subject was the compilation of "An Introduction to the Study of Metallurgy", first published in 1891 and revised in later editions, each growing in bulk and usefulness, the fifth edition being published just before his death.

During the twenty-two years of his professorship, Roberts-Austen was associated with many eminent colleagues. Huxley became dean in 1881 and continued to direct the work of the Royal School of Mines and the Royal College of Science until his death in 1895. Other familiar names are those of Judd, Warington-Smyth, Le Neve Foster, Frankland, Edward Thorpe, Guthrie, Rücker, Goodeve, and Perry. Norman Lockyer, who had been associated with Roberts-Austen in an investigation of the quantitative analysis of alloys by the spectroscope so early as 1873, was appointed to the chair of astronomical physics contemporaneously with him in 1881.

Alloys Research

Roberts-Austen had long wished to ascertain whether the influence of small quantities of impurities on the physical and mechanical properties of metals is governed by any law. The general interest which had been aroused in the 'eighties by the enunciation of periodicity by Newlands and by Mendeléeff, in relation to the chemical properties of the elements, had, no doubt, led him to seek some such generalization in regard to alloys.

In a paper to the Royal Society in 1888, "On Certain Mechanical Properties of Metals considered in Relation to the Periodic Law", he reviewed some of the practical implications of the presence of small amounts of other elements in metals of relative purity. It was as the direct outcome of this work that we find recorded in the *Proceedings of the Institution of Mechanical Engineers* (Annual Report, January 29, 1890, p. 6) that, on the recommendation of Dr. Anderson, the Council had decided upon starting an Alloys Research Committee, with the object of furthering the investigations which Roberts-Austen had already made, but with special regard to the physical and mechanical properties of iron, copper, and lead. Reference was also made to a previous suggestion by Mr. John A. F. Aspinal as to the desirability of inquiring into the serious deterioration experienced during recent years in the durability of copper fire-boxes and brass tubes of locomotive boilers. The hope was expressed that one result of the investigations might be to elucidate the causes of these failures and that "the laws regulating the effects of small admixtures of other elements with iron will also be arrived at".

Thus we see that the original intention of those responsible for setting up this Committee was that the inquiries should embrace both non-ferrous and ferrous metallurgy, terms, however, not then in general use. Under the chairmanship of the then Director-General of Ordnance Factories at Woolwich, Dr. (afterwards Sir William) Anderson, it was only natural and, moreover, fortunate that the scope of the investigations should be a wide one.

During the ten years which followed, five reports were presented to the Institution. It was, perhaps, through the medium of these reports and the vigorous discussions which they provoked that Roberts-Austen's enthusiasm had the greatest practical effect, leading to widespread and permanent results. The reports were mainly exploratory, and at times seemingly discursive, but coming, as they did, at a time when men occupying the highest positions in the engineering world were frankly sceptical as to the possibility of the pyrometer or the microscope serving any real purpose as an indication of the suitability of material for engineering work, they did much to arouse interest and to carry conviction to those dealing with metallurgical problems differing very widely in their character. One of the features, in fact, of Roberts-Austen's usefulness at this time was the close touch he kept with workers in many fields, from whom came inquiries and information which might never have reached the notice of a less accessible person. At a time when such rapid advances were being made in all directions, the work with which the Committee had entrusted him did much to establish and to uphold the best traditions of metallurgical research in Great Britain.

The First Report, 1891

At the outset Roberts-Austen directed attention to Osmond's recent work on the allotropy of iron and his experimental study of the action of impurities on iron. His admiration of Osmond's work was repeatedly manifested during the years which followed, and a close friendship and intimate correspondence continued between these two men until the end. In fact, it is just, I think, to say that in many ways Roberts-Austen was Osmond's disciple, preaching the gospel of allotropy in Great Britain and introducing to his countrymen, in the later reports, the exquisite metallographic technique which Osmond had developed. A considerable part of the first report was directed to the question of temperature measurement as a fundamental necessity in carrying out the proposed investigations.

The Second Report, 1893

Attention was given to matters having a practical bearing, and exhaustive experiments were described of the effects of impurities on copper.

The effect of pressure on metals was next considered and particulars were given of experiments to lower the recalescence point of steel by compression.

Chromium steel was examined and Roberts-Austen directed attention to the importance of studying the relation of this metal to carbon and to iron. How little could he have anticipated the part which this metal was to play in those steels in which his own name was to be perpetuated by his friend Osmond!

The Third Report, 1895

Much of the work which followed was in the nature of exploratory research in various directions. Curves were shown of the cooling of electro-iron, of standard gold containing bismuth, of aluminium-copper alloys, and of iron-aluminium alloys. Observations were made of the spontaneous disintegration of the latter. The welding of iron was then examined in conjunction with Sir Thomas Wrightson. Experiments in welding were made by electrical means, and pyrometric measurements were made during the application of pressure to the plastic iron with the object of ascertaining whether the operation is attended by a fall of temperature as in the regelation of ice.

An important appendix included in this report was by Alfred Stansfield on the alloys of copper and tin; it represents the first attempt to explain this series as a whole.

The Fourth Report, 1897

The opening paragraphs of this report contain much that is of historic interest, and they constitute, moreover, a concise statement of the position which the Committee's work had reached, and the stimulus it had given to similar work in France. Roberts-Austen added: "It should not be forgotten, moreover, that excellent investigations on alloys have also recently been made at Cambridge by Heycock and Neville, whose work has been carried on side by side with that of our Committee".

He concluded these opening paragraphs by saying: "As regards the immediate future, I am of opinion that the nature of what may be called 'Solid Solutions' of metals must be more carefully studied than has hitherto been the case. . . . It will be necessary to place on a firmer basis our knowledge of the mechanical constitution of metals and alloys, as revealed by the pyrometer and the microscope, before attempting to explain how 'structure' is built up of the ultimate atoms or molecules of the metals". This, of course, with no inkling of the contributions to the questions of structure which the physicists were to make within a very few years.

Following the work on the alloys of copper and tin given in the third report came a similar investigation of those of copper and zinc, which had been in progress for nearly two years. Freezing-point curves of this series of alloys were published for the first time in this report.

The diffusion of metals, which had long occupied his attention and which had recently formed the subject of his Bakerian Lecture to the Royal Society, was discussed in relation to alloys generally. With regard to the diffusion of solid metals in each other, it was pointed out that the experiments had shown that it is possible actually to observe and measure the migration of the constituent atoms in a metal or alloy at the ordinary temperatures, pointing to unexpected possibilities of structural changes in metals used in engineering construction generally. His determination of the coefficient of diffusion of gold in solid lead was the first of its kind and has proved to have been very nearly correct. His interest in this aspect of molecular mobility is surely traceable to his early association with Graham.

The Fifth Report, 1899

The ultimate transference of the work of the Alloys Research Committee to the National Physical Laboratory was foreshadowed in the opening paragraphs of this report.

The Committee had exerted a noteworthy influence in connexion with the preliminary inquiry which had led to the recommendation by a Treasury Committee, of which Roberts-Austen was a member, that a National Physical Laboratory should be established, having its control vested in the Royal Society.

The results of the experimental work published in this report, which are of outstanding importance, are those which sought to support the view that the iron-carbon alloys should be considered as solutions and brought into line with ordinary saline solutions. The curves already given in the previous report had clearly indicated the possibility of such an explanation, but the provision of a new and highly sensitive method of recording temperature changes, which was described at length, made it possible to resume this investigation.

Although such cooling curves had been obtained previously by Osmond so long before as 1888, and more recently by Henri Le Chatelier, those given by Roberts-Austen in the fourth report constituted the first attempt to embody in curves a comprehensive series of results.

The latter part of the fifth report was devoted almost entirely to a description of the methods of microscopic examination and to a discussion of its possibilities. It was perhaps this aspect of the work which attracted the greatest attention at a time when information regarding the technique of metallography was scanty and not readily accessible. The apparatus which had been improvised became the model from which more elaborate arrangements were installed in many centres of industry throughout the country, but more directly at the Royal Arsenal, Woolwich, at Elswick, and at Cambridge.

To those who were his personal assistants during these years, and to whom he owed so much, Roberts-Austen made generous acknowledgment: to Henry C. Jenkins (First and Second Reports), to Alfred Stansfield (Third, Fourth and Fifth Reports), to William H. Merrett (Fourth, Fifth, and, after his death, the Sixth Reports) and to A. J. Brett (Fifth Report).

One may also mention the names of others who at one time or other went to the Mint for varying periods and worked in the vaulted chambers collectively known as "The Cellars". Of these, Carpenter, Rosenhain, Hudson, Law, Bengough, Bannister, Reinders and Campbell are names which are identified with the period which saw the birth of the Institute of Metals. Sir Thomas Kirke Rose had been one of his official colleagues during this period and had collaborated with him in papers to the Royal Society.

I may perhaps recall that the first president of the Institute of Metals, Sir William White, was, at the termination of Roberts-Austen's work, chairman of the Alloys Research Committee and president of the Institution of Mechanical Engineers, and it was in no small measure due to his unfailing support and to his foresight that the work was continued at the National Physical Laboratory and that the Institute of Metals became the medium by which the results of so many later researches have been made available to the workers of all nations.

Departmental Committees

Running concurrently with the later phases of the Alloys Research Committee's reports were the increasing demands made upon Roberts-Austen's time and energy by official committees of inquiry set up by various Government Departments. Of these, the first in which his authority in regard to matters relating to iron and steel received recognition was that of a committee appointed in 1896 by the Board of Trade to inquire into the "Loss of Strength of Steel Rails through Use on Railways". The investigations were prolonged, the final report appearing four years later (1900). A summary of this work was afterwards presented to the Institution of Civil Engineers.

From time to time the Ordnance Committee of the War Department had submitted to him samples of steel used in the manufacture of guns and armour plate, and he continued until his death to be in active co-operation with the War Office and with the Admiralty in elucidating problems in the manufacture of ordnance.

In 1900 he was appointed a member of a special committee set up jointly by the Admiralty and the War Office to consider certain questions which had arisen in relation to explosives and ordnance. This committee was composed of distinguished men who were quite independent of either of the two Services. Lord Rayleigh was chairman and with him were Sir Andrew Noble, Sir William Crookes, the Right Hon. R. B. (afterwards Lord) Haldane, and Roberts-Austen. His own contribution to the work of this committee followed the lines of his earlier work. His death, however, prevented the completion of this work, which, it was said, promised to furnish valuable information.

Addresses

While his contributions to the *Transactions* and *Proceedings* of various scientific and technical bodies contain the records of his experimental work, it is to his addresses that we must turn to find the best expressions of a vivid personality which was a constant inspiration to those who knew him. These addresses were models of arresting exposition and constitute valuable contemporary records; they reveal clearly how very much 'worth-while' he found metallurgy to be.

Of these addresses, two are outstanding, and these came towards the close of his career. They were the presidential addresses which he delivered in 1899 and 1900 to the Iron and Steel Institute. In the first he gave an exhaustive review of the contributions made by Great Britain to the progress of the metallurgy of iron and steel during the nineteenth century, while in the second, delivered in Paris at the autumn meeting, he reviewed the contributions made by France during the same period. The circumstances accompanying the latter occasion were, in many ways, brilliant, coinciding, as they did, with the memorable Exhibition of 1900 and attracting a representative gathering of metallurgists from all countries. His friend, Osmond, translated his address into graceful French prose.

Henry Marion Howe, the distinguished American metallurgist and personal friend of Roberts-Austen, writing some years after his death, said: "The data which he recorded may be replaced by still more accurate and fuller ones. But his methods of presentation will retain their value unlessened, because they are adapted to the unchanging human mind. . . . The reason why on returning to London we went first to the Mint was that we met there one who welcomed us, not for his own sake, but for ours; who was truly glad to put his researches off till night in order that he might quicken us. You felt instinctively that you drew inspiration from his look and presence and became better fitted for receiving whatever is uplifting and broadening in the world's metropolis."

Roberts-Austen lived wholly for the progress of metallurgy, and he did much in his day and generation to stimulate others to share his enthusiasm and his conviction of how much more there was to come.

FRESHWATER FISHERIES IN THE BRITISH COLONIAL EMPIRE

By Dr. E. B. WORTHINGTON

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COLONIAL development is being much discussed, and when scientific and other resources can be released for peace-time activities, we can assume that the new imperialism will, in the spirit of the age, concentrate on those aspects of progress which affect directly or indirectly the standard of life of the Colonial peoples. With this in view the Colonial Research Committee has already been busy for six months or so, and the establishment of a Colonial Products Research Council with executive powers has recently been announced (see NATURE, Jan. 23, 1943, p. 105).

So much work in recent years has gone to show that adequate and well-balanced feeding is an essential basis for bodily health and mental development that it is needless to labour its necessity for Colonial peoples, except to emphasize that in many of the Colonies the constituents of diet often most deficient are animal protein and mineral salts. Much work is being done to increase the supply of meat by the many Colonial departments devoted to agriculture and veterinary work, and the special organizations aiming at the control of pests such as tsetse flies and locusts. Nevertheless meat is still very short as an article of diet among Colonial peoples and is likely to remain so. It is natural, therefore, to turn to the possibilities of providing the deficient ingredients from fish, which already contribute materially, but could do much more.

Attention has been directed to the potentialities of the marine fisheries of the British Colonial Empire in recent years, particularly by Kemp[1] in his presidential address to Section D (Zoology) of the British Association in 1938. There are, moreover, the fisheries departments which have been at work for many years in the Dominions and in Malaya, Ceylon and Palestine, with more recent developments in Hong Kong and the West Indies, and a new investigation now proceeding in West Africa. Meanwhile the junior partner, freshwater fisheries, has had few spokesmen in spite of the fact that fresh water is often capable of contributing even more than the sea to the cooking pots of the Colonial peoples. It is, of course, the great continental areas rather than the island colonies where freshwater fish come into prime importance. The British Colonial territories in Africa, for example, contain appreciably more than 50,000 square miles of fresh water, and, as a glance at a population map of Africa makes clear, there is a strong tendency for the people to congregate along the many hundred thousand miles of shore-line bordering these waters, especially in the area of the great lakes. It is scarcely surprising that freshwater fisheries of importance have grown up, but the diversity and scattered nature of the industry make it almost impossible to assess its value, either in terms of food or cash, except in a few instances. Several things are known for certain about these fisheries, however: many waters are capable of producing far more fish than they do at present; improved communications are causing new markets to be opened; and in certain waters easy of access the troubles of over-fishing are already becoming pressing.

Lake Victoria, which comprises 26,800 square miles of water all less than 270 ft. deep, is a good example; its 2,000 or so miles of coast are shared by Kenya, Uganda and Tanganyika. Statistics for the fish production are by no means complete, but a conservative estimate gives the local value at the landing points as about a quarter of a million pounds sterling a year. Practically the whole of this goes to the native market at an average price of rather less than 20 cents of a shilling per lb., so that the total annual production in terms of weight is, in round figures, about 10,000 tons. This, compared with the area of water of the whole lake, is equivalent to a crop of 1·4 lb. per acre per annum, which is ridiculously small compared, say, with about 15 lb. per acre taken annually from the North Sea, or much higher crops taken from fresh waters in various parts of the world. The reason for the poor showing of Lake Victoria is that only the inshore fringe of the lake is used by the fishery. In that fringe there are certain fish of high qualities, notably the ngege or African carp (*Tilapia esculenta*), which from time immemorial have been the quarry of numerous lacustrine tribes. European fishing methods, especially gill-nets, were introduced in 1905. Over-fishing was soon suspected as the first enormous catches fell off, and this led eventually to a six-month fishery survey in 1927. In his report on that survey[2], Graham gives an exhaustive analysis of the ngege fishery, backed by hydrographic and ecological data, with accounts of other fish resources which are being or might be developed. The recommendations for the restriction of mesh, etc., to conserve the ngege fishery were implemented by Kenya in 1932 and 1933, when fish protection rules and a system of inspection were instituted, but the administrations of Uganda and Tanganyika did not follow, so there is no common policy as yet. Thus Lake Victoria presents a big problem of undeveloped resources (if the whole lake were cropped at the rate of the North Sea, the catch would be multiplied at least ten-fold), coupled with a problem of local over-fishing. Neither of these problems can be solved without intensive research.

As another example there are Lakes Edward and George connected by the Kazinga Channel; they lie between Uganda and the Belgian Congo and comprise 960 square miles, of which part is shallow productive water and part deep. In 1930 a brief fishery survey was conducted here by the Cambridge Expedition to the East African Lakes[3], which revealed the fish resources, and since then a native fishery has been encouraged by the Uganda Government. In 1939, the most recent year for which figures are available, 1,060 tons of dried and salted fish (some 4,000 tons as landed) worth £24,000 were sold to the Belgian Congo, and large quantities not easy to estimate went to the Uganda markets. This is a good illustration of the high production of which these tropical waters are capable, for here, as in Lake Victoria, the fishery is restricted mainly to the inshore waters. Careful control will have to be exercised, however, if a repetition of the ngege fishery in Lake Victoria is to be avoided, and this will require the attention of scientific men as well as administrators.

The same story of large undeveloped resources is told for Lake Albert and Lake Kioga in Uganda[4], where several enterprises have been started under European management since a brief fishery survey in 1928; and the basic information for development of Lake Rudolf is available for the time when transport routes from that isolated area to the Kenya markets are developed. More recently, fishery surveys have been carried out on the great lakes farther south, namely, Lakes Nyasa[5], Lakes Rukwa and Bangweulu[6], which likewise tell of undeveloped resources coupled here and there with the danger of local over-fishing in the more accessible waters. The fishery of Lake Tanganyika still awaits examination, which is odd in view of the great attention this lake has received from men of science, and there is a long list of waters of less area but all capable of producing many tons of food every year.

There is another aspect to this subject, which has potentialities in every Colony and is not dependent on large lakes or rivers, namely, fish ponds. It is well known that, even in temperate climates, fresh water under careful management can be made to produce more animal protein food per unit area than can good farm land. Thus the fish farms of Central Europe may produce up to and more than 400 lb. of fish, such as carp and rainbow trout, per acre of water per annum, compared, say, with 200 lb. of beef or mutton from pasture land of high quality. In many parts of the British tropical Colonies the rigours of climate and animal disease are such that the cropping rate of domestic animal protein is very much less than in Europe; but the productivity of fish should be capable of even greater development on account of the higher water temperatures and lack of winter. Thus there may be a big future for fish farming in the Colonies, in ponds specially constructed for the purpose, properly managed and manured. For intensive fish farming in warm climates we have already the outstanding example of the Chinese, who see to it that every square yard of water produces a crop of fish. In some Colonies there has already been a considerable interest in the possibilities and actual development, especially in Malaya and Palestine, but in the great areas of Africa where sea fish are not available and opportunities for fish ponds extensive, the subject at present is mainly in the suggestion stage. Before such a new industry can be established, intensive research work is necessary in order to bring to bear our knowledge of productivity in water, of manuring and of the life-histories of different species of fish. Such research should not be unduly delayed because it might go a long way to solve many problems of food supply, particularly those experienced by large employers of labour on plantations and mines in the great tsetse fly belt of Africa, where animal protein is so difficult to provide. The large peace-time imports of Norwegian stock fish to the west coast of Africa are by no means sufficient to supply the need.

Now coming to what might be done to help these industries along the right lines, it is a striking fact that, whereas large sums of money have been spent, with great advantage, on the development and control of agricultural, forest and mineral resources, the total spent up to now on freshwater fisheries runs to very few thousand pounds, and the regular annual expenditure on supervision is probably nil, being met from the charges for licensing fishermen, boats and nets. Lord Hailey, in his "African Survey"[7], when describing the many agencies which are designed to assist development of the British African Colonies, was unable to mention any such agency concerned with fisheries, and in the volume on "Science" which accompanied the survey[8], though I devoted a chapter to fisheries, reference to those of the British Colonial territories had to be extremely brief because so little work on them had been accomplished, and organization for their development and control scarcely existed. Since then, a Colonial Fisheries Committee was appointed in 1939 under the Economic Advisory Council, but the War intervened, and this Committee went into abeyance before it had an opportunity to meet. The case seems to be clear cut, and conclusions point to freshwater fisheries being one of those subjects which should be scheduled for development, with assistance from funds under the Colonial Development and Welfare Act, as soon as conditions for scientific work in the Colonies improve. Therefore it may not be out of place to sketch the sort of organization which might be envisaged to bring this development about, with reference particularly to the East African region, where potentialities are greatest.

It will be necessary to have: (1) a uniform system for inspection, control, and the collection of fishery statistics; and (2) a sound organization for research. The first may have to be arranged independently in each territory for the time being, until some form of closer union between the African Dependencies comes into being. In the research organization, however, which will start almost from scratch, there should be a great opportunity for avoiding the scientific isolation, local administrative control, and other troubles which have rendered a deal of Colonial research almost stillborn. Inland fisheries are unlikely to become so important as to warrant big organizations in each Colony, and a few experts scattered here and there could not provide the necessary skill in the diversity of subjects involved, namely, chemistry, botany, zoology, statistics and even economics. Therefore the research should be on a regional basis, and for the East African region we can envisage a central fishery laboratory with an aquarium, probably on Lake Victoria, as the seat of the largest fishery. It would be close to the central African air route and no more than four or five days travel from England. Here a team of workers would be equipped with a research vessel on Lake Victoria and motor transport for excursions of a few months duration to other lakes. They would be responsible through their director to the Colonial Fishery Committee in London, but would maintain close contacts with the local administrations and also with the institutes for fishery research and with the British Museum (Natural History) in England. A system of staff exchange for periods up to a year between the fishery centres in Africa and home institutions would go a long way to overcome scientific isolation.

The staff of this suggested centre would, at least in the early stages, be directed along lines connected with economic developments, because the extreme kind of free research is almost incompatible with a centre devoted to a special objective. As such they would, of course, be constantly held up for lack of work on pure research. To overcome this difficulty, which is ever-present in the Colonies, the laboratory should be made as attractive as possible to visitors from the home country. These should be attracted by an abundant provision of research facilities and special funds wherewith to defray air travel and living expenses of approved workers, who would come for periods of three months to a year to conduct their own research on relevant subjects. The biological characteristics of the tropics, and the growing realization in universities and institutions in Great Britain of responsibility for the Colonies, may well attract many a research worker to spend his long vacation by the lakes, swamps and rivers of East Africa.

By such means we can envisage a growing band of young workers with tropical experience, some of whom may be available when the time comes after a few years for the establishment of a second centre for inland fishery work, perhaps in the area of Lake Nyasa, and staff which will inevitably be required for developments in other Colonies. In this way the central station on Lake Victoria would in time come to act for Colonial inland fisheries in the same capacity but on a smaller scale as that fulfilled for Colonial agriculture by the Imperial College of Tropical Agriculture, Trinidad. The cost of such a research organization would not be large. An initial capital expenditure of £10,000 would probably suffice, and the annual budget would be in the neighbourhood of £6,000, rising after five years or so to £10,000. There is every reason to believe that the cost would be seen back many times over in the form of enlarged fisheries established on sound scientific lines, and in the increased welfare of the Colonial peoples who would consume the product.

[1] Kemp, W. S., Nature, 142, 819 (1938).

[2] Graham, M., "The Victoria Nyanza and its Fisheries" (Crown Agents for the Colonies, 1929).

[3] Worthington, E. B., "A Report on the Fisheries of Uganda" (Crown Agents for the Colonies, 1932).

[4] Worthington, E. B., "A Report on the Fishing Survey of Lakes Albert and Kioga" (Crown Agents for the Colonies, 1929).

[5] Ricardo Bertram, C. K., Borley, H. J. H., and Trewavas, E., "Report on the Fish and Fisheries of Lake Nyasa" (Crown Agents for the Colonies, 1942).

[6] Ricardo, C. K., "Report on the Fish and Fisheries of Lake Rukwa and the Bangweulu Region" (Crown Agents for the Colonies, 1939).

[7] Hailey, Lord, "An African Survey" (Oxford University Press, 1938).

[8] Worthington, E. B., "Science in Africa" (Oxford University Press, 1938).

SEX EDUCATION AND GUIDANCE

AN EDUCATIONAL PROBLEM

By DR. R. SUTHERLAND

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SEXUAL intercourse outside marriage is generally regarded as a breach of our moral code. It is impossible therefore to gauge exactly the extent to which it is occurring, but the extra-marital conceptions and venereal disease infections which often result from it are some measure of its frequency. Roughly a hundred thousand of the children born in Great Britain during 1938 were conceived outside marriage, and during the same year there were at a rough estimate forty-seven thousand new cases of venereal disease. Not every sex adventure leads to conception, however, and the patients who have contracted venereal disease from their first illicit intercourse are very much in the minority. Consequently, extra-marital intercourse must be by no means uncommon.

There is little doubt that war conditions have led to a further slackening of moral standards. Family life has been disrupted, young people are far from the restraining influence of home, and life for many has become less sure. It is not surprising, therefore, that last year the number of new cases of venereal disease in Great Britain increased to roughly seventy thousand among civilians alone. Apart from its significance as an indication of spreading moral laxity, this increase affects the war effort, the health and happiness of the community, and the welfare of innocent spouses and unborn children.

The Minister of Health has recognized that this problem must be tackled and has had the courage to initiate a campaign to break down the taboo that has in the past so sadly interfered with the attack on venereal diseases. His Chief Medical Officer, Sir Wilson Jameson, made history by speaking frankly of the venereal disease menace in a radio talk last year; and the Ministry of Health is now collaborating with the Central Council for Health Education in giving widespread publicity to the facts about venereal disease through advertisements which are to appear for the next six months in the national and provincial newspapers. The Ministry and the Central Council have also arranged for film and poster displays, and the Central Council has produced a variety of leaflets for distribution to the public.

If the campaign of public education is to be successful, however, there must be an honest examination of all aspects of the problem as well as a free and frank discussion of the nature, methods of spread, and signs and treatment of the disease. This has been recognized by the Central Council for Health Education, which has been charged by the Ministry of Health with the responsibility for the central provision of education in this as in other health matters. Accordingly, on February 26, the Central Council held a conference in London which was attended by more than a thousand representatives and medical officers of English and Welsh local authorities, and at which the various methods of approaching the problem were freely discussed by a large number of speakers, among whom were the Archbishop of Canterbury (president of the Central Council), and the Minister of Health. This conference, sitting under the chairmanship of Dr. Charles Hill, chairman of the Central Council, should be of the greatest value in helping the churches, the Ministry, the Central Council, and local authorities to work out the agreed and co-ordinated national educational policy, which the Minister of Health urged is needed.

As the Archbishop of Canterbury said, the problem is only partly medical because spiritual, moral and social considerations are involved (see also NATURE, **150**, 529; 1942). The Archbishop went on to say that the moral element is the most important and should have the first attention. At a similar conference held in Scotland the following week, however, the Moderator of the General Assembly of the Church of Scotland maintained that the medical problem should be dealt with at the same time as the moral problem. In this he was supported by the Secretary of State for Scotland.

The need for developing the moral approach is generally accepted, but dispute rages hotly over the extent to which a purely medical or epidemiological approach to the problem can be justified. All are agreed that venereal disease could be practically ended if all extra-marital intercourse were avoided.

The difficulty is that the sexual urge, upon which the spread of venereal disease depends, is one of the most powerful primitive instincts, and that, as the figures for extra-marital conceptions and new cases of venereal disease show, the moral forces and social measures so far at work have signally failed to keep it fully under control. On the other hand, it must be recognized that, however successful it might be in dealing with the epidemiological problem of venereal disease, a medical approach which largely neutralized moral teaching and encouraged promiscuity might in the long run do more harm than good. This is what the Archbishop fears. Are his fears justified?

In the past, the moral attack on lax sex conduct, and consequently on venereal disease, has been greatly handicapped by the public attitude towards sex education. We can now look forward, however, to rapid developments in this field. Children and young people should be brought up to a full knowledge of their own bodies and of those of the opposite sex. Sex should be a mystery no longer, and it should cease to be associated in the child's mind with the naughty and the furtive. The child's innocent curiosity about sex should be satisfied naturally as it arises; and, before he becomes emotionally involved at adolescence, he should understand his own body, the workings of sex, and the moral and social reasons for self-control and continence. The spiritual teachings of the churches would thus be immensely strengthened by an enlightened self-interest which would encourage the youth to defer immediate satisfaction in the interests of adult happiness and of his future home and family. The stress should be on pride in chastity rather than upon fear of the possible consequences of promiscuity. Information about the venereal diseases should therefore be given naturally as part of instruction in the communicable diseases. Although all the basic information should have been given before puberty, the emotional problems of the adolescent should be sympathetically discussed at the time when they are likely to arise. The educators, whether teachers or youth leaders, must themselves be taught, and the Central Council for Health Education is prepared to give this instruction if asked to do so by local authorities.

There must, however, be a social approach to the problem as well. The demands made upon self-control must appear reasonable and the rewards fairly certain and not too distant. Conditions of employment and of housing must therefore offer the prospect of early marriage. As the Archbishop said, young people must have ample opportunity of enjoying each other's company in innocent activities amidst pleasant surroundings.

We must not disregard the assaults upon youthful self-discipline that are constantly being made by erotic magazines, books, films, and revues, and by alcohol.

When we come to consider the medical, or epidemiological, approach we are on much more controversial ground. Nevertheless, "the wages of sin is death" policy is almost universally out of fashion, and all are agreed that there must be adequate and convenient facilities for the early treatment of those who have not been continent and have as a consequence developed the first manifestations of venereal disease. Differences of opinion appear when the logical epidemiologist asks why we should wait until infection has actually taken place before starting treatment. He contends that the medical treatment of the problem should begin immediately the spiritual, moral, and social approach has failed; that is, as soon as any individual has succumbed to the temptation to extra-marital intercourse. He maintains that hundreds of thousands are exposing themselves to infection each year and that we must not just leave them to their fate. To do so involves not only great mental distress, some disability, and much trouble and expense, but often exposes innocent people to the risk of infection. He therefore urges that all young people should be informed of the preventive measures which will very largely reduce the chances of infection if a risk is taken. These measures include the use of a condom as a mechanical barrier to the passage of the germs, self-treatment by thorough washing and chemical applications to the parts immediately after exposure, and in addition, or alternatively, attendance at a treatment centre as soon as possible for prophylactic treatment by experts.

If there were only the narrow medical problem of venereal disease to be considered, this course would undoubtedly be the correct one, and its general application would soon reduce these diseases to relatively negligible proportions. Not one case of venereal disease has occurred, for example, among tens of thousands of persons who received prophylactic treatment at a treatment centre within twenty-four hours of exposure to the risk of infection. But the Archbishop considers that instruction on prophylaxis would be bound to have an adverse effect upon the reaction of the young to spiritual and moral teaching. If he is right in thinking that prophylactic teaching would inevitably amount in effect to incitement to fornication, then obviously the epidemiological arguments in favour of such teaching must be disregarded. But is he right ? Is it in fact impossible to find teachers who could combine the moral and medical approach in such a way as to inspire high ideals of sex conduct, while yet openly recognizing that the flesh is sometimes weak and that some of the pupils may succumb to temptation, and should at least protect themselves from disease ? Are we not deceiving ourselves if we fail to recognize that, however good and undiluted the moral teaching may be, it will fail in many cases ? Need a realistic recognition of this fact necessarily mean an increased number of failures ?

Surely the time has come to convert this no-man's-land upon which this moral versus medical controversy is raging into a common ground on which the moralists, the educationists, and the medical men can meet to try to work out an agreed venereal disease policy which will improve our national moral standards at the same time as it reduces the incidence of venereal disease. The Central Council for Health Education has made a beginning by providing a platform for the free exchange of views on this important question. It now only remains for the various schools of thought to resolve their conflict and work together in this great cause.

OBITUARIES

Prof. J. Eustice

PROF. JOHN EUSTICE, late head of the Faculty of Engineering in University College, Southampton, was the son of a Cornish mining engineer. He was trained first at the School of Mines, Camborne, and then at the Royal College of Science ; he was a Whitworth Scholar, and a National Science Scholar.

In 1891 he became lecturer in engineering to the Hampshire County Council, and in the next year joined the Hartley College, Southampton, where he formed its engineering side. For forty years he built up the Engineering Department until his retirement in 1931. By that time he had developed courses for the external B.Sc. degree in engineering of the University of London and also an active system of part-time and evening instruction for the apprentices and employees of engineering firms in the district. The difficulties of this development must have been very great, and to one who relieved him on his retirement the marvel was that he had achieved so much with so little equipment and accommodation. In addition to the technical instruction, he kept in his own hands the large administrative work of the evening classes as they grew up.

Prof. Eustice could find little time for research, but he did make a very beautiful study of the flow of liquids in curved pipes. The system of showing coloured stream lines in laminar flow had been used by Osborn Reynolds and Hele Shaw, but Eustice adapted the same general method to show the complicated three-dimensional pattern in which the stream lines interweave as flow passes round a curved tube.

On his retirement at the age of sixty-seven, Prof. Eustice was thoroughly tired out, but he had two great assets : great love of his church and all connected with it ; and a keen interest—and a good performance—in golf. He changed to the new conditions with remarkable success, and his retirement must have been very happy. His activity and good health lasted to within a few days of his death on February 24 in his seventy-ninth year.

T. R. CAVE-BROWNE-CAVE.

WE regret to announce the following deaths:

Mr. Joseph Bunny, late of the Nigerian Forestry Service, on March 9.

Dr. C. N. Haskins, Chandler professor of mathematics at Dartmouth College, U.S.A., on November 14, aged sixty-eight years.

Mr. R. W. Sayles, research associate of the Division of Geology, Harvard University, on October 23, aged sixty-four.

NEW FELLOWS OF THE ROYAL SOCIETY

THE following were elected fellows of the Royal Society on March 18:

SIR SHANTI SWARUPA BHATNAGAR, director of scientific and industrial research, India. Distinguished for his numerous contributions to physical chemistry, more especially to magneto-chemistry. As professor of chemistry in the University of the Punjab he built up a flourishing school of research. Since the outbreak of war he has organized a new scientific department of the Government of India.

PROF. P. A. BUXTON, director, Department of Entomology, London School of Hygiene and Tropical Medicine. Distinguished for his researches in medical entomology with special reference to the conditions under which insects responsible for the transmission of diseases multiply and the measures which must accordingly be adopted for their control.

PROF. I. DE B. DALY, professor of physiology, Edinburgh. Distinguished as an originator of essential items of modern physiological technique, and for his important contributions to the physiology of the circulation in the lungs and the bronchial tubes.

VICE-ADMIRAL SIR A. EDGELL, R.N., hydrographer of the Royal Navy. Distinguished for the organization and encouragement of work in tidal research, in determining gravity at sea and in magnetic and electric survey of the oceans.

DR. A. J. EWINS, director of research, May and Baker, Ltd. Distinguished for his chemical and biochemical researches. His work in organizing an industrial research laboratory has led to the production of some of the most important synthetic remedies in recent years.

DR. A. FELIX, bacteriologist, Lister Institute. Distinguished for his contributions to serology and bacteriology. He is particularly associated with the Weil-Felix reaction for the diagnosis of typhus fever and with the antigenic analysis of bacteria.

PROF. ALEXANDER FLEMING, professor of bacteriology, St. Mary's Hospital, London. Distinguished for his contributions to bacteriology, immunology and chemotherapy. His work includes the very important discoveries of lysozyme and penicillin.

DR. J. J. FOX, Government Chemist. Distinguished for his application of physical methods to the discovery of the structure of chemical substances and for his work on new analytical methods and chemical processes.

DR. W. M. H. GREAVES, Astronomer Royal for Scotland. Distinguished for his contributions to stellar spectro-photometry and for the discussion of the colour temperatures of early type stars.

DR. S. C. HARLAND, plant breeder. Distinguished for his contributions to the study of genetics and especially of the cotton plants. His researches have not only been of practical value for tropical agriculture, but also have led to important advances in fundamental aspects of evolutionary theory.

PROF. G. A. R. KON, research professor of chemistry at the Royal Cancer Hospital. Distinguished for his researches in organic chemistry. During recent years his work on the polyterpenes has provided the basis for a number of important developments.

DR. A. MCCANCE, director and general manager, Messrs. Colville's, Ltd., Motherwell. Distinguished for his work in the steel industry and particularly for his applications of physical chemistry to the processes of steel making.

PROF. WILDER PENFIELD, director of the Montreal Neurological Institute. Distinguished for his researches in neuro-histology and as a neuro-surgeon.

DR. G. E. PILGRIM, formerly superintendent of the Geological Survey of India. Distinguished for his contributions to the geology of India, particularly in the field of Tertiary stratigraphy, and for his researches in vertebrate palæontology.

DR. R. E. STRADLING, chief adviser, Research and Experiments Department, Ministry of Home Security. Distinguished for his researches on the properties of building materials and for his direction of the Building and Road Research Stations and of researches relating to civil defence.

DR. C. SYKES, superintendent of the Metallurgy Department of the National Physical Laboratory. Distinguished both for his fundamental scientific advances in the study of alloys and for the practical improvements which he has effected in various branches of metallurgy.

PROF. J. L. SYNGE, professor of applied mathematics, Toronto. Distinguished for his contributions to mathematics, particularly to the geometry of dynamics, the theory of relativity, hydrodynamics and electricity.

PROF. G. F. J. TEMPLE, professor of mathematics, King's College, London. Distinguished for his contributions to mathematical physics, particularly to quantum theory, relativity and mechanics.

DR. A. L. DU TOIT, lately consulting geologist to the De Beers Consolidated Mines. Distinguished for his contributions to the geology and petrology of South Africa, particularly his work on the Karroo system and his comparative study of the equivalent succession of South America.

PROF. SOLLY ZUCKERMAN, professor of anatomy, University of Birmingham. Distinguished for his studies on the morphology and relationship of the Primates and on their reproductive physiology. He has also made outstanding contributions to the study of social behaviour in the lower Primates.

The election of Sir Shanti Swarupa Bhatnagar to the fellowship of the Royal Society is a well-deserved recognition of his distinguished contributions to the advancement of science. The event is indeed a signal one, for he is the first Indian chemist to receive this high honour.

As a young Indian M.Sc. graduate he went in 1919 to Prof. F. G. Donnan's laboratory at University College, London, where he carried out a series of investigations on the stability and inversion of emulsions, obtaining the D.Sc. degree of the University of London in 1921. Returning to India, he went first to the Benares Hindu University, and, in 1924, to the University of the Punjab at Lahore, where he was appointed to the professorship of physical chemistry. Here he began to build up a university school of physico-chemical teaching and research, which through his own personal investigations and those of his collaborators and students soon became one of the most active and successful centres of chemical research in India. His name is particularly well known for his investigations on magnetism and its relation to atomic and molecular structure. Together with K. N. Mathur, he wrote an important work entitled "Physical Principles and Applications of Magnetochemistry" (Macmillan and Co., Ltd., London, 1935). Apart from these magnetochemical investigations, the researches carried out in the University Chemical Laboratories at Lahore under the directorship of Sir Shanti have covered a wide field, including, among many other subjects, surface actions, photochemistry, and chemi-luminescence.

Although a number of industrial concerns in India have asked for and obtained valuable scientific help from him, Sir Shanti has consistently refused any personal financial reward. As a result, he has received from them very considerable sums of money for the improvement of the scientific equipment of the University Chemical Laboratories at Lahore and the foundation of research scholarships.

When in April 1940 the Board and Council of Scientific and Industrial Research was formed by the Government of India, Sir S. S. Bhatnagar was appointed the first director. The very important work already carried out by this Government research organization has been largely due to the great energy and ability of its director, whose valuable national services have been recognized recently by the conferment on him of a knighthood.

It is no exaggeration to say that a component and very important part of the great work which India is doing in the War is due to the successful labours of the Board and Council of Scientific and Industrial Research, and it is a source of deep satisfaction that the Board's first director of research is an eminent Indian man of science and a fellow of the Royal Society of London.

NEWS and VIEWS

Reconstruction and a Council of Europe

THERE have been comments from various sources in recent months to the effect that Mr. Winston Churchill was too preoccupied with the direction of the War to give adequate attention to questions of the reconstruction to follow it. His broadcast address on March 21 was an answer to such criticism; it was delivered in measured terms, and set forth his views on the future of Great Britain, of Europe, and of the world. The first essential is, of course, the utter destruction of Nazism, and Mr. Churchill suggested that the first stage will be its disappearance from Europe. This will be the time to build up, on the lofty conceptions of freedom, law and morality which was the spirit of the League of Nations, a sort of Council of Europe, consisting of the great European States, associated with confederations of lesser States, so that "we shall achieve the largest common measure of the integrated life of Europe that is possible without destroying the individual characteristics and traditions of its many ancient and historic races". Towards this end, discussions are already taking place. Achievement of this project, however, will be possible only when the nations realize that none of them will be able to achieve the full satisfaction of its individual desires. The Council of Europe would be followed by a Council of Asia, leading on to a world organization.

The Prime Minister's Four Years Plan

TURNING to the domestic affairs of Great Britain, Mr. Churchill said he would propose a Four Years Plan to cover the period of transition and reconstruction which must follow the end of the war in Europe. Such a Plan would comprise five or six large measures of a practical character, all of which would require careful preparation in advance in order that they might fit into the general scheme. This scheme would have to receive the approval of the country at large. One such measure should be a scheme for compulsory national social insurance, and Mr. Churchill said that he and his colleagues are making the necessary preliminary legislative preparations. Agriculture must be maintained at a higher level by reviving healthy village life, so that Great Britain will not be so dependent on imported foodstuffs as hitherto. A national health service is another necessity, to combat the dwindling birth-rate as well as to carry on the war against disease. Education is also being actively studied. "The future of the world is to the highly educated races who alone can handle the scientific apparatus necessary for pre-eminence in peace or survival in war." Education must be broader and more liberal, with due consideration of the lessons of the past; and opportunities for advanced education must be available to all. Religion has been a fundamental element in the schools of Great Britain, and must continue to play its part in building character. Secular schooling must be extended, and plans made for part-time education for those entering industry. The physical reconstruction made necessary by air-raid damage must also be planned effectively and preparations made well in advance.

Mr. Churchill concluded on the note of finance. He said that the Government will be responsible to the people for the money which they have provided for the war effort; this involves stabilization of prices. Taxation, though it will necessarily be high after the War, must not stifle enterprise. The Government is preparing measures to enable it "to exercise a balancing influence upon development which can be turned on or off as circumstances require". The State must increasingly concern itself with the economic well-being of the nation, but must nevertheless revive as soon as possible a vigorous private enterprise. The intense demands for goods, both for home and export, which will come immediately the War ends, need not be succeeded by a disastrous slump such as that which followed the War of 1914–18. Under the stress of war, industry has learned new methods; electrification has increased 50 per cent; and new industries have arisen. Thus the radio industry, gas and electricity will be faced with many opportunities for expansion and service; and transportation of all types must be developed. Throughout his address, Mr. Churchill stressed the need for work, for service and for general preparedness for the future, although he deprecated attempts to fill in detail or commit the country to large-scale expenditure in a future which cannot yet be clearly envisaged.

Evolution of Colonial Territories

THE debate on March 16 in the House of Commons on Colonial affairs may well come to be regarded as marking the beginning of a new phase in the handling of Colonial affairs—the phase that must follow and give substance to the accepted aspirations for the advance of the Colonial peoples to economic security, social well-being and ultimate partnership as responsible communities in the British Commonwealth. It was a first discussion of concrete but comprehensive plans for the development of one of the main regional entities into which the consideration of Colonial development will have, in increasing measure, to be grouped. The Stockdale Report, the proposals for a new constitution in Jamaica and the work of the Anglo-American Caribbean Commission which provided the substance of Colonel Stanley's speech, touched on every aspect of the development of the West Indies and raised the concrete issues involved in the next stages of advance. The Colonial Secretary himself emphasized the need to start with practical solutions of concrete problems. The proposals for the Jamaican constitution, published as a White Paper, attempt to give expression to the largest possible consensus of local opinion. Thus a bi-cameral system has been recommended, despite official demands for great simplicity, on the ground that a great deal more depends upon the spirit in which any constitution is going to be worked than upon the actual machinery that is devised. The proposal is seen as only a stage on the way. The paramount aim is declared to be to ensure further advances towards complete responsible government.

The Stockdale Report, in the same way, concentrates on the most essential needs and the recommendation of immediately practical remedies without losing sight of the long-term problems. Here the Colonial Secretary wisely emphasized the danger of reaction from recent conditions of insecurity in the export trade to too great a measure of self-sufficiency, which would condemn the West Indies and many other Colonial areas to an intolerably low standard of living. Here again, the achievements and the programme of the Anglo-American Commission constitute an immediate and practical response. By providing an organization which will bring the British West Indies and the rest of the Caribbean area together to find common solutions for their problems, the Commission is an instrument for the first, modest but indispensable, steps necessary to fit them into a prosperous world economy. All this is evidence of an enlightened and purposeful empiricism long overdue in the approach to Colonial problems.

Education and the Colonies

PROF. A. V. HILL, in the debate on Colonial affairs in the House of Commons, has given his powerful aid to recent pleas for the active support and co-operation of the universities of the British Empire in the advance of Colonial education. He recalls the opportunity for their active participation in the training of the body of teachers and scientific and professional men that the Colonial peoples so greatly need, and must provide as rapidly as possible from their own ranks. He suggests not only taking a mission—with a harmonium rather than a big drum—around the universities to enlist their active contribution, but also the establishment of a central organization of some kind to watch over the needs of the higher education of Colonial peoples and to bring their needs and the opportunities these offer continually to the notice of schools, universities and learned societies at home.

There can be little doubt that both the universities and the Colonies would derive great mutual benefit from the closer contacts that would follow from an increasing flow of students from the Colonies to Great Britain and of visiting teachers, lecturers, educational advisers and examiners from the universities to every part of the Colonial Empire. Moreover, Colonial development and welfare, as Prof. Hill declared, provide some of the grand adventures of our time. They constitute a creative task of social transformation. The initiative, energy and enthusiasm of many able young men and women in our schools and universities can be enlisted for the task of helping at the birth of these new societies. The immediate need is the widest appreciation of the needs and opportunities, and practical machinery which can operate without delay when the War is won.

Post-War Air Transport

THE debate upon post-war air transport in the House of Lords on March 11 disclosed several points of a technical nature. Viscount Cranborne said that it is the Government's wish to allot spheres of influence by international collaboration, and to avoid the cut-throat competition between air lines that have made it necessary in the past to grant subsidies in order to keep the services running in a manner worthy of the nation. The question of obtaining experience in air transport with the most modern aircraft, engines, and equipment is to be dealt with by the creation of an Air Transport Command within the R.A.F. This command will deal primarily with transport of materials and men, and its needs will bring parts of the industry into that sphere of design and production. Thus at the end of the War an organization should be in existence that can be changed over to civil air transport with the minimum of dislocation. It has since been announced that Air Chief Marshal Sir F. W. Bowhill, at present commanding officer of the R.A.F. Ferry Command, is to be in charge of this new section. Attention was also directed to the fact that a well-developed air transport service would be a valuable auxiliary to an invasion force operating on the European continent. Other suggestions were that a Ministry of Air Transport should be created immediately, to make plans for the future based on its present-day experience, and that the shipping companies might be asked to run air services, auxiliary to their ships, allotting each item of traffic to that class of transport most suited to its requirements.

Air Estimates in the House of Commons

SIR ARCHIBALD SINCLAIR, Secretary of State for Air, discussing the Air Estimates in the House of Commons on March 11, mentioned several points of technical interest in recent R.A.F. development. During the past year, it has been found possible both to raise the standard of skill demanded and lengthen the period of training given in the R.A.F.; this at a time when it is known that both have been reduced in the enemy organization. One concrete result has been that the number of flying accidents during the past year was 20 per cent less than in the previous year. A very great expansion of training facilities has taken place, a joint Empire Air Training agreement being now in operation in the United Kingdom, Canada, Australia, and New Zealand. Expansion and improvement has taken place in the Air-Sea Rescue Service operating wherever the Allied air services are called upon to fly across the sea. An interesting variant of this, organized on similar lines, is the African desert rescue service, which has already saved about a hundred lives.

Another innovation is the introduction of a Commando Servicing Unit. Skilled mechanics, armed and trained to fight when necessary, are able to repair damaged aircraft under conditions that would normally mean their abandonment, and a very great saving in equipment has resulted. Tribute was also paid to the R.A.F. regiment, which has constantly been in the van of the advancing infantry, and has been able to re-condition enemy airfields even under fire. The effect of our bombing raids on Germany and the occupied countries goes far beyond the actual hold-up in the production of war material. Damage to transport systems and related workshops disorganizes the even flow of supplies to works, and delays the transport of troops to areas where they are required. The materials and labour necessary for the repair of damaged buildings also has to be diverted from war production.

Sir Bennett Melvill Jones, C.B.E., F.R.S.

SIR BENNETT MELVILL JONES, whose appointment to succeed Sir Henry Tizard as chairman of the Aeronautical Research Committee has been announced, has had a long and distinguished connexion with the scientific side of aeronautics. While his interests have ranged over almost the entire field of the subject, his name is more particularly associated with the elucidation of the problems arising out of the performance of aircraft. His work has resulted in a steady increase in the efficiency of the flying machine as a whole, and this, particularly when devoted to raising the speed of flight, has set problems in stability and control that have called for complex and systematic investigation both in the laboratory and in actual flight. Following his student days at Cambridge he took up aeronautics at the National Physical Laboratory, Teddington, and so far back as 1912 contributed a paper to the old Advisory Committee for Aeronautics on the properties of aerofoils. A paper on the stability of kite balloons (1915) was another contribution of his that laid the foundation of the systematic study of stability in flight. He then spent a period with Messrs. Armstrong Whitworth on the development of rigid airships, and followed this by work at the Royal Aircraft Establishment, Farnborough, on flight research. During the War of 1914–18 he was a member of the Experiment and Research Department of the newly constituted Air Board, and took an active part in the development of aerial warfare, particularly aerial gunnery, principally at the Experimental Station at Martlesham Heath.

Later, Melvill Jones was appointed Francis Mond professor of aeronautics in the University of Cambridge, a post which he still holds, and also became a member of the Aeronautical Research Committee. During that period he has contributed much to the development of those outlooks on aeronautics which he has made his own. He has been able to combine his theoretical work at the University with actual full-scale flying experiment at the R.A.F. station at Duxford. One of his most noted achievements during that period was to present a conception of the ideal streamlined aeroplane, suggesting general rules for its design that quickly received universal acceptance. During the present War he has been principally concerned with the development of fighting technique. He was elected a fellow of the Royal Society in 1939 and received his knighthood in 1942.

Royal Astronomical Society Gold Medallist

As already announced, the Gold Medal of the Royal Astronomical Society has been awarded to Dr. H. Spencer Jones, Astronomer Royal, for his determination of the solar parallax from observations of the minor planet Eros, made at the very favourable opposition of 1931. The solar parallax is a fundamental unit and is the astronomer's disguise for the principal astronomical unit of distance, namely, the mean distance of the earth from the sun. Dr. Spencer Jones' result for the solar parallax (v. *Mon. Not. Roy. Ast. Soc.*, 101, 356; 1941) is 8·790″ ± 0·001″ and the corresponding mean distance of the earth from the sun is 93,003,000 miles; in each case the accuracy is of the order of 1 part in 10,000. Such an achievement is remarkable, and the Society's award will be acclaimed by astronomers all over the world as an honour deservedly bestowed and brilliantly earned.

The actual observations of Eros, made photographically at about a score of observatories, are represented by nearly three thousand plates; in addition, the positions of several hundreds of primary reference stars and nearly six thousand fainter secondary stars had to be determined. The successful planning of an international campaign of this magnitude was, in itself, no mean feat. The discussion of the immense amount of observational material secured has evidently been thorough, and the Astronomer Royal appears to have overlooked no possible source of error. The Eros observations also provide means of determining accurately the moon's mass and the constant of nutation: the value of the latter is found to be inconsistent with the value usually accepted, and the Astronomer Royal's next activity would seem to be the resolution of this discrepancy.

A New Method of Etching on Metals

A NEW electrolytic process of etching on metals makes use of a standard waxed-paper stencil such as is used in a duplicating machine, on which is cut the required design. This is placed between the metal article, which forms the anode, and an absorbent pad containing the etching reagent, which is connected to the cathode of a 15-volt D.C. circuit. The apparatus consists of a unit comprising the transformer, rectifier and output controller, giving a 15-volt D.C. supply from the 200/230-volt A.C. mains. When etching stainless materials, each stencil is good for at least fifteen etchings, or for about ten with less resistant alloys. The normal depth of attack is about 0·0005 in., and curved and irregular articles can be treated. The process is adapted to the marking of tools, plates, etc. The equipment is obtainable from Messrs. Griffin and Tatlock, Ltd., Kemble Street, Kingsway, London, W.C.2.

Training of Civil Servants

THE Chancellor of the Exchequer has announced that he has set up the following committee to consider the training of Civil servants: The Financial Secretary to the Treasury (Mr. Assheton), chairman; Sir Harold Hartley, vice-president, London Midland

and Scottish Railway Company; Sir Kenneth Lee, chairman, Tootal Broadhurst Lee Company, Limited; Miss Myra Curtis, principal, Newnham College, Cambridge; Mr. A. J. T. Day, chairman, staff side, National Whitley Council; Mr. A. L. N. D. Houghton, staff side, National Whitley Council; Sir Thomas Gardiner, director-general, General Post Office; Sir Robert Wood, deputy secretary, Board of Education; and Mr. H. Wilson Smith, under-secretary, Treasury. The terms of reference of the Committee are: "To examine the general question of the training of Civil servants, including the question whether a Staff College should be established, and if so, the particular form and character which that college should take".

Earthquake in Mid-Atlantic

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentre of the earthquake of December 31 which took place at about 12h. 03·7m. U.T. The instrumental data on which the calculations were based were obtained from the observatories at St. Louis, Tucson, Sitka, San Juan, Burlington, Pasadena, Spring Hill, Lincoln, Huancayo and Fordham. The epicentre turned out to be in the vicinity of latitude 18·1° N., longitude 47·0° W. This is in the region of the mid-north-Atlantic ridge between Puerto Rico (West Indies) and the Cape Verde Islands. Earthquakes are known to occur in this region from time to time and it would be interesting to have reports of the shock from ships which may have been in the region at the time.

Comet Oterma (1942*f*)

DR. WHIPPLE has computed the following elements of this comet:

T	1942 December 18·859	
ω	358° 03·0′	1942·0
Ω	78 30·8	
i	17 57·6	
a	11·9604	
e	0·86622	
P	41·4 years.	

Its positions for a few dates in April are given below. For intermediate dates it will be sufficiently accurate to interpolate, allowing a daily motion in R.A. +2·7m. during April 2–12 and +2·2m. during April 12–28. The corresponding figures in declination are −0·2° and −0·1°. It is not an easy object to find as its magnitude in the middle of the month, assuming the $\rho^2 r^4$ law, is about 13·5.

Date 1943	R.A.	Dec.	ρ	r
April 2·0d.	7h. 02·2m.	+40·9°	1·723	2·038
12	7 29·5	38·9	1·957	2·121
28	8 05·3	37·1	2·207	2·239

Comet Whipple (1942*g*)

THIS comet is no longer a naked-eye object but can be seen with the aid of a small telescope. Positions are given for the early part of April.

Date 1943	R.A.	Dec.	ρ	r
April 2·0d.	12h. 42·9m.	+46·5°	0·729	1·565
6	12 44·3	44·9	·762	·594
10	12 45·6	43·3	·796	·624

The Night Sky in April

NEW moon occurs on April 4d. 21h. 53m. U.T., and full moon on April 20d. 11h. 11m. Conjunctions with the moon are as follows: April 7d. 11h., Venus 6° N.; April 9d. 01h., Saturn 3° N.; April 12d. 05h., Jupiter 3° N.; April 29d. 17h., Mars 0·1° S. Occultations of stars brighter than magnitude 6 are as follows: April 16d. 22h. 16m., χ Leo (D); April 18d. 21h. 55·3 m., γ Vir. (D); April 18d. 22h. 43·2m., γ Vir. (R); April 25d. 03h. 42·6m., 21 Sgr. (R). The times are given for Greenwich and D and R refer to disappearance and reappearance respectively. Mercury is in superior conjunction on April 4, reaching its greatest eastern elongation on April 30 when it sets about 21h. 25m., two hours after sunset. Venus, an evening star, is in conjunction with Saturn on April 25d. 04h., Venus 3·1° N. Mars souths at 8h. 34m. in the middle of the month, but is too low for favourable observation in Great Britain. Jupiter souths at 17h. 42m. in the middle of the month and is well placed for observation in the earlier portion of the night. Saturn sets about 23h. in the middle of the month and will soon be too close to the sun for favourable observation. Times of setting are given approximately for the latitude of Greenwich. The Lyrid shower of meteors, April 18–24, which has not been very strong in recent years, will not be easily observed owing to moonlight.

Announcements

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, will deliver the Pilgrim Trust Lecture before the Royal Society on May 6: he will speak on "The Organization of American Scientists for the War".

THE trustees of the Ray Lankester Fund have appointed Dr. Shu-Ping Chu, of Queen Mary College, University of London, as investigator for 1943–44 to carry out research at the Plymouth Laboratory of the Marine Biological Association into the effect on the development of marine algæ of the presence or absence of different substances in sea water.

THE following appointments in the Colonial Service are announced: R. A. Hutchinson, to be veterinary officer, Gambia; A. R. J. McGregor and E. J. Westcott, to be veterinary officers, Nigeria; C. B. Garnett, senior agricultural officer, to be assistant director of agriculture, Nyasaland.

A CORRESPONDENT of *The Times* writing from Gibraltar states that tunnellers of the Royal Engineers working there have discovered a hitherto unknown cavern. It is said to be of extraordinary beauty, with white, grey and red stalactite columns, and contains a lake of fresh water nearly 40 yards long and 7 ft.–20 ft. deep. The largest column is 7 ft. in diameter and 40 ft. high.

A USEFUL 16 pp. brochure on the preparation and preservation of insects for collections has been written by J. Manson Valentine of the U.S. Department of Agriculture and is published as No. 6, vol. 103 of the *Smithsonian Miscellaneous Collections* (November 1942). Although it has particular reference to the order Coleoptera it will be found applicable to some other orders of insects also. The methods of mounting, preserving, relaxing, labelling, etc., and other treatment of specimens are clearly described. Some of the technique explained will be found useful and more especially by British workers who are not always familiar with American methods.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Action of Fluorine on the Teeth of Rachitic Rats

As is well known, the injection of sodium fluoride solution in small amounts causes a hypercalcified line in the dentin of teeth developing at the time of the injection, and thus this substance acts as a very elegant 'marker' for experimental procedures (Fig. 1). I have been using sodium fluoride for this purpose in experiments in which rats have been on diets with a high Ca-P ratio (4 : 1) or a low Ca-P ratio (0·25 : 1).

The histological appearance of the continuously growing rat's incisor tooth with either of these diets is virtually the same. Fig. 2 shows that of the labial side of the upper incisor of a rat on a low ratio diet. The chief departure from normal is the very wide and irregular predentin.

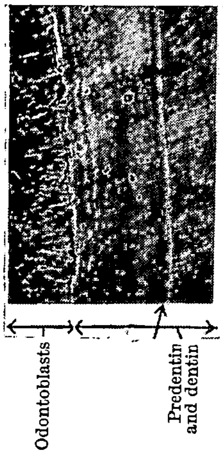

Fig. 1.

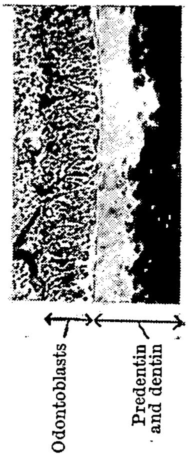

Fig. 2.

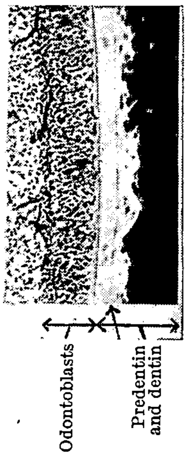

Fig. 3.

Fig. 1. LONGITUDINAL SECTION OF THE LABIAL DENTIN OF A NORMAL RAT'S UPPER INCISOR TOOTH. 0·3 C.C. OF 2% SODIUM FLUORIDE SOLUTION WAS INJECTED SUBCUTANEOUSLY 10 DAYS PREVIOUSLY. THE ARROW POINTS TO THE FLUORINE LINE IN THE DENTIN. (× 100.)

Fig. 2. LONGITUDINAL SECTION OF THE LABIAL DENTIN OF THE UPPER INCISOR OF A RAT ON THE LOW CA-P RATIO DIET. NOTE THE WIDE PREDENTIN. (× 100.)

Fig. 3. LONGITUDINAL SECTION OF THE LABIAL DENTIN OF THE UPPER INCISOR OF A RAT ON THE LOW CA-P RATIO DIET. 0·1 C.C. OF 2% SODIUM FLUORIDE WAS INJECTED SUBCUTANEOUSLY 10 DAYS PREVIOUSLY. THE ARROW POINTS TO THE FLUORINE LINE IN THE PREDENTIN. (× 100.)

The subcutaneous injection of sodium fluoride into rats on high Ca-P ratio diets causes a hypercalcified line in the dentin corresponding to the predentin laid down at the time, when that ultimately calcifies, but no visible change in the predentin itself. In the case of animals on the low Ca-P ratio diet, however, a fine calcified line appears in the predentin long before this would normally become calcified (Fig. 3). The injections were made in all cases 10 days before the animals were killed, and the predentin laid down between the calcified line and the odontoblast margin was formed during the last ten days of the animal's life.

It would thus appear that the pathological changes in the teeth with high and with low Ca-P ratio diets are not the same, despite their histological resemblance. It is, of course, well known that the changes in bone with these two types of diet are quite dissimilar[1]. It can also be concluded that the action of fluorine on teeth is governed to a large extent by the diet, and presumably by the levels of calcium and phosphorus in the blood. With a high blood calcium, conditions are not such that calcium can be readily deposited in the tissues, whereas with a low blood calcium, deposition is facilitated, and, in fact, the calcified line may even be calcium fluoride. Incidentally, the injection of sodium fluoride almost invariably causes tetany in the animals on the low Ca-P ratio diet, but usually produces no visible effect in the animals on the high Ca-P diet, unless in such doses as to depress the heart. The protective action of high calcium diets against the toxic action of fluorine has been noted by Lawrenz and Mitchell[2].

Schour and Smith[3] consider that fluorine acts directly on the odontoblasts in causing changes in the dentin, but my findings do not completely support this view.

It will be noted that the wide predentin with low ratio diets is due to considerable retardation in the rate of dentin calcification. Normally this begins twenty-four hours after the predentin has been formed. In rats on low ratio diets, I find that predentin is not calcified until 15–20 days after it has been laid down.

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Jan. 20.

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New Synthesis of Glycolesters

A CONTINUED investigation of the 'crossed' Cannizaro reaction[1] has been undertaken. It was possible to effect a condensation for the first time between an aliphatic saturated and an unsaturated aldehyde, with the aid of co-ordination catalysts of the type of magnesium aluminium ethoxide, $Mg[Al(OC_2H_5)_4]_2$. Two molecules of butyraldehyde and one of crotonaldehyde condensed to form an unsaturated glycolester, the structure of which was shown to be the following:

$$CH_3-CH=CH-CHOH-CH(C_2H_5)-CH_2-O-CO-C_3H_7.$$

From the unexpected manner of interaction it was deemed reasonable to extend the work into the aliphatic saturated series of aldehydes. The following compounds were examined: acetaldehyde, proprionaldehyde, butyraldehyde, *iso*butyraldehyde, hexaldehyde, alpha-ethyl-butyraldehyde, heptaldehyde and alpha-ethyl-hexaldehyde. Magnesium aluminium *iso*propoxide and magnesium aluminium butoxide were also used.

It was found that the co-ordination catalysts are able to condense three molecules of the aldehyde to yield mainly glycolesters, whereas the simple alkoxides as, for example, aluminium ethoxide, condense only two to give simple esters. This was observed in the case of the straight-chain aldehydes. The alpha-alkyl substituted aldehydes undergo mainly the simple ester condensation with the aid of either type of catalyst.

The complex catalysts serve two functions as distinct from the simple alkoxides: namely, they cause an esterification preceded by an intermediary aldolization; whereas the simple alkoxides only esterify. The formation of the glycolesters can be represented as follows:

$$R-\mathrm{CH_2}-\mathrm{CHO} + R-\mathrm{CH_2}-\mathrm{CHO} \xrightarrow{\text{catalyst}}$$

$$R-\mathrm{CH_2}-\mathrm{CHOH}-\mathrm{CH}(R)-\mathrm{CHO} + R-\mathrm{CH_2CHO}$$

$$\xrightarrow{\text{catalyst}}$$

$$R-\mathrm{CH_2}-\mathrm{CHOH}-\mathrm{CH}(R)-\mathrm{CH_2}-\mathrm{O}-\mathrm{CO}-\mathrm{CH_2}-R.$$

The bifunctional influence of the catalyst may be attributed to the 'intermediate' basicity of the co-ordination complex compound, which is formed from the more basic magnesium alkoxide and the less basic aluminium alkoxide:

$$2\ \mathrm{Al}(\mathrm{O}R)_3 + \mathrm{Mg}(\mathrm{O}R)_2 = [\mathrm{Al}(\mathrm{O}R)_4]_2\mathrm{Mg}.$$

The more basic media favour aldolization. Some related magnesium compounds of the type $R\mathrm{OMgI}$ are able to form aldols. The 'average' basicity so attained in the formation of the co-ordination compound seems to enable both the aldolization and esterification.

The work described above was presented before the autumn meeting of the American Chemical Society, Buffalo, N.Y., in September last. A more detailed account of the investigation will be published in due course.

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Jan. 18.

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[1] Nord, F. F., *Chem. Rev.*, 3, 65 (1926).

Inhibition of Tumour Growth

THE retardation of the growth-rate of tumours in experimental animals by chemical compounds and by extracts of tissue has been the subject of numerous investigations, and the fact that inhibition can be produced by so large a number of compounds suggests some general effect on metabolic processes. Samuel and Kugelmass[1] have shown that an acid-forming diet fed to young rats produces a much slower rate of growth than does an alkali-forming diet.

Preliminary experiments in this series have been reported[2] from these laboratories indicating an attempt to determine whether a tendency towards acidosis in a mouse would influence the growth-rate of tumours, ammonium chloride being administered to mice which had been inoculated with the Twort carcinoma. The ammonium chloride was given in the drinking water as a 0·6 per cent solution while control mice inoculated at the same time were given water. Administration of ammonium chloride has also been used as a concomitant treatment with *H*.11 extract in clinical cases of advanced inoperable cancer.

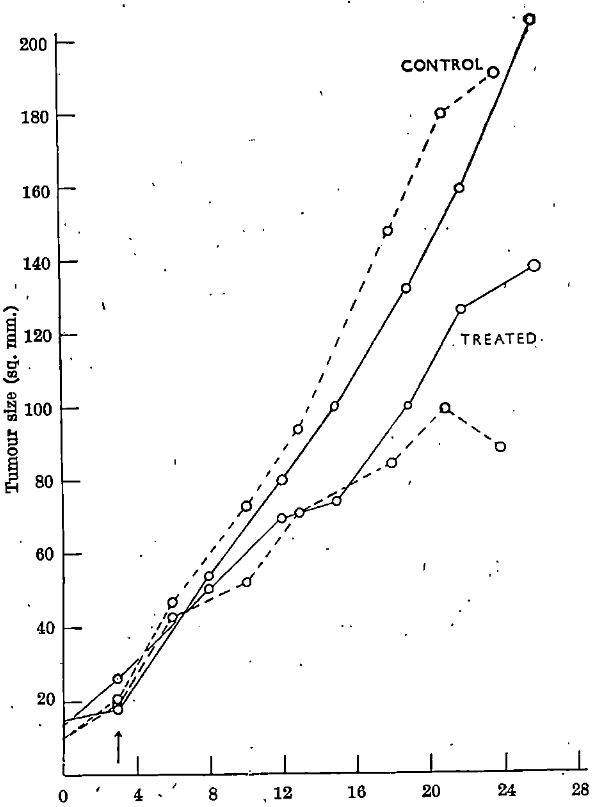
The experiments reported below were carried out on five batches of mice, the total number of surviving treated mice being 56 and of surviving controls 55. Tumour diameters of both groups were measured at intervals and size is recorded as the product of the two diameters. As an index of growth-inhibition, the difference between the average tumour size of the treated and untreated animals is expressed as a percentage of the average control size. An analysis of the results is given in the accompanying table. In the graph, tumour sizes at the various dates of measurement have been averaged and plotted against the time for experiments 328*A* and 328*B*.

EFFECT OF AMMONIUM SALTS ON TUMOUR GROWTH.

Expt. No.	No. of mice		Aver. tumour size (sq. mm.)		Aver. tumour wt. (gm.)		Inhibition %	
	C	T	C	T	C	T	size	wt.
$\mathrm{NH_4Cl}$								
316*A*	17	18	293	149	2·32	1·75	49·2	25·0
319*B*	4	05	323	200	2·76	1·37	38·1	50·0
324*B*	6	11	339	246	2·03	1·07	27·4	47·3
328*A*	15	10	199	137	0·88	0·58	31·2	34·1
328*B*	13	12	177	89	0·70	0·32	50·0	54·3
$\mathrm{CH_3COONH_4}$								
328*B*	13	11	177	136			23·2	
333*C*	11	7	137	62			54·6	
333*E*	9	6	94	80			14·9	
334*B*	7	6	90	74			17·8	

Mice were inoculated 7 days prior to administration of ammonium salts; latter given in 0·6 % solution for approximately 21 days.

At the end of the experiments the mice were killed and the tumours excised. Cystic fluid (if any) was drained and removed from the surface of the tissue by laying the tumour on filter paper, and the tumours were immediately weighed. The percentage inhibition



—— Experiment 328*A*. Average of 15 controls; 10 treated.
---- Experiment 328*B*. Average of 13 controls, 12 treated.

by weight was calculated by expressing the difference between the average final weights of the control and treated tumours as a percentage of the average weight of the control tumours.

These experiments show that the administration of a small quantity of ammonium chloride may cause a considerable reduction in the growth-rate of a tumour. That this inhibition is not due to any variation in tissue fluid content is shown by the figures given for tissue weight, which show inhibitions as considerable as those for tumour size. (The large difference between the degree of inhibition shown on the basis of weight and volume in the cases of experiments 316*A* and 324*B* was, however, due to the fact that the tumours in one set of animals contained more cystic fluid than those of the others.) No retardation of body growth of the treated mice was found in these experiments. The direct cause of the inhibition is not clear. Attempts to measure the degree of acidosis produced by titration of the urine of the animals with alkali were unsuccessful, as any differences were less than the variation in the individual groups.

Preliminary experiments have been carried out using other salts in an attempt to elucidate the problem. Of these, the results obtained by the administration of ammonium acetate in a similar manner to the chloride are reported in the table. These results do not confirm the original experiment mentioned in an earlier publication[2]. The inhibition was less than that produced by ammonium chloride but, in contrast, ammonium lactate has, in our early experiments, shown no inhibitory action ; in fact, an acceleratory effect was indicated. Since the acetate radical of ammonium acetate would presumably be rapidly oxidized, it is difficult to imagine the direct production of even a mild acidosis by this substance. If the diuresis induced by the formation of urea from the ammonium radical produced an appreciable acidosis, inhibition would be expected by administration of all ammonium salts. This assumption is not supported by the results with the lactate.

Investigations along these lines are proceeding, but the purpose of this communication is to point out that caution must be exercised in the interpretation of many of the results obtained by numerous investigators after administration of substances to tumour-bearing animals. Most of those shown to be inhibitory have been acids or substances which could easily give acids. Amines, for example, were usually administered as hydrochlorides, while bisulphite compounds themselves are strongly acid. In the preparation of tissue extracts, such as those employed by Boyland[3] and Roffo[4], and in the inhibitory extracts of urine described by Thompson *et al.*[2], the possibility exists that some part of the activity may be due to relatively simple salts.

We are indebted to Dr. N. Hajdu for assistance in this research.

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[1] Samuel and Kugelmass, *Proc. Soc. Exp. Biol. Med.*, **27**, 195 (1929–30).

[2] Thompson *et al.*, *Med. Press and Circ.*, **205**, 334 (1941).

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Apparent Stimulative Effect on Mould Growth of a Mercurial Preparation

It was observed in the course of some experiments on the prevention of mould growth on leather that a preparation of an organic mercurial—used in the very low concentrations of 1 in 40,000 and 1 in 20,000—appeared to have a stimulative rather than an inhibitive effect on mould growth. Growth began earlier on samples treated with this preparation than on water-soaked controls, and was more profuse.

This finding is reported, since it appears to be analogous to observations on the stimulative effect on mould growth of certain copper and cobalt salts and—to a lesser degree—of mercury, reported by W. A. R. Dillon Weston and R. Eric Taylor[1].

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[1] Nature, **151**, 54 (1943).

Delayed Implantation in the Stoat (*Mustela mustela*)

Recent investigations have shown that the discontinuous type of embryological development first described in the roe deer[1,2] is less uncommon than was originally supposed[3]. In this and some other species the blastocyst is formed normally, but there is a period of several months during which it lies free in the uterine lumen before it becomes implanted. Both the European badger[4] and the American badger[5] show this type of delayed development, and recently it has been described in American weasels[6] and martens[7]. According to Fischer[4], unimplanted blastocysts are found in the European badger from the end of July until January, the young being born in March. Wright[6] finds that in the long-tailed American weasel blastocysts lie dormant from July or August until about the following spring, the young being born in April. Watzka[8] is said to have found a similar delay in implantation in the stoat.

A study of the reproductive cycle of this common British species was published by me in 1935[9] from material collected in the field between 1930 and 1934. Although animals were kept in the laboratory for periods varying up to six months, most of the females did not thrive and there seemed little chance of their breeding in captivity, especially as no records were found of this having taken place. It was clear, both from the literature and from a cursory examination of the material, that stoats generally had one litter a year born in March or April. In the late spring and summer, however, both adult and first-year female stoats mated and ovulated, and it was puzzling that there were no further litters during the male fertile period, which lasts from February or March until July. The corpora lutea from those ovulations differed markedly in size and histological appearance from those of the spring pregnancies, as did the corresponding uteri. First-year females which had ovulated showed no development of the mammary gland rudiment.

The apparent absence of pregnancies after the late spring and summer matings was originally attributed to the luteal stimulus being inadequate for implantation, owing to a reduced level of pituitary activity[9]. The possibility of delayed implantation in the stoat was not investigated, for I was unaware of Fischer's[4] and Hamlett's[5] work on the badger. The recent observations by Wright[6] and Watzka[8] suggested that delayed implantation would explain the peculiarities of the reproductive cycle of the female stoat, and ample evidence has now been obtained from the original material of the persistence of unimplanted blastocysts. Serial sections have shown that they can be found in first-year and parous stoats in every month of the year. The blastocysts, which are spaced in the uterus, are of the type seen in American weasels[6] and martens[7]—di-laminar with a differentiated ectoderm and an inner cell mass; the zona pellucida is extensive and generally distorted in fixation. The blastocysts show no obvious changes in their long period free in the uterus except for an increase in size during their first few months. Blastocysts occurred in a lactating female so early as April 15 and in first-year stoats, only two months old, in June. The latter included an 85 gm. animal taken on June 2, which was less than half-grown. The males of the same litters remain immature until they are about ten months old. Apparently most of the spring and summer matings are fertile, but since no older embryos or new-born young are found before the following spring, the quiescent period may last more than ten months in parous stoats, and nine months in those breeding for the first time.

The corpora lutea corresponding to the resting blastocysts often resemble those from a recent ovulation and this, combined with the occurrence of œstrous stoats in September, October and December, suggested originally that stoats ovulated several times in the year. It is clear that more than one œstrous period a year is possible—for example, a post-lactation stoat was on œstrus in June, all similar animals in the series having ovulated in April or May—but from the numbers of stoats with uteri in the resting luteal phase it would seem that the majority develop blastocysts as the result of their first post-partum ovulation, or at sexual maturity, and reproductive activity is suspended until March. Watzka[8] concludes that some stoats both mate and have their litters in the spring, but it seems likely that these would only include a small minority of the females, such as those referred to above, which are non-pregnant at the end of the male breeding season. Stoats in the present series taken in February and March provide no conclusive evidence of recent matings. The unimplanted blastocysts in these animals had reached approximately their full size. Occasional spermatozoa can be found in the uterine glands, but these are also present in three January stoats and may merely represent histological survivals. The possibility that early breeding season matings have taken place cannot be excluded, but no œstrous or pro-œstrous stoats were found earlier in the year than April, and these were recently parous.

The onset of active embryological development in the spring is preceded by enlargement of the corpora lutea, after which the uterus becomes œdematous and takes on an œstrous appearance, both processes suggesting a rise in the circulating œstrogens following renewed stimulation of the ovary by the pituitary gland. The uterus doubles or quadruples its weight while, concurrently, in first-year stoats the mammary glands proliferate and form small distinct nipple areas. All these changes take place before the uterine epithelium undergoes the immediate pre-implantation changes.

It was estimated previously[9], from the dates on which pregnant and lactating stoats were taken in the field, that pregnancy lasted for about a month in spring. With the addition of 10–12 days to this period to allow for the formation of the blastocyst in the preceding year, the duration of pregnancy, excluding the quiescent phase, might well be six weeks as in the closely related ferret[10]. Delayed implantation in the Mustelidæ appears to be confined to species with only one litter a year. There is no evidence that it occurs in the ferret or the European weasel[11], which may have two litters. Further investigation of the latter species is in progress.

I am indebted to Dr. E. C. Amoroso for examining the blastocysts.

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Czechoslovak Medical Students at Oxford

THE conferment of degrees of Czechoslovak universities on a group of medical graduands at Oxford on February 27[1]—*spectaculum tam novum tamque magnum*—may serve to recall the almost forgotten name of Daniel Stolczius Cuttenus, of the family of Pardubští, domiciled formerly at Kutná Hora in Bohemia. This student-poet of alchemy graduated at Prague in 1618, and five years later published a remarkable alchemical work, "Viridarium Chymicum" ("Pleasure Garden of Chymistry"), consisting of a collection of 107 copper-engravings, each provided with a Latin epigram. Although Stolczius does not appear to have become a member of the University of Oxford, he dated the dedication of the "Viridarium" from Oxford, July 6/16, 1623, and in it he wrote: "In this my journey abroad, undertaken in the cause of Medicine . . . I hear with grief of the strange and pitiable disasters of my country, and am, to my extreme sorrow, very often interrupted by these tumults of war that are scattered everywhere". It is interesting to find this link between Prague, Oxford, and medical studies, at the outset of the Thirty Years' War.

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[1] NATURE, **151**, 274 (1943).

THE BOTANIC GARDEN, OXFORD*

BY a change of Statute, approved on March 9, the University of Oxford's ancient Botanic Garden enters yet another phase of its history.

The Garden was founded by the Earl of Danby in 1621: it is thus the oldest Botanic Garden in Britain and the sixth oldest in Europe. In that year Danby secured the lease of a piece of swampy water-meadow from Magdalen College and made it over to the University for a physic garden. This lease has been renewed from time to time for more than three hundred years.

Danby first built the wall and gateways, then had the level of the ground raised in an attempt to avoid floods. Some time previous to 1641 he appointed Jacob Bobart gardener on a ninety-nine-year agreement, with benefit of the produce and a payment of £40 per annum for labour and materials. Bobart on his part undertook to keep the garden planted with trees and plants requisite for "the service and use of the said University". It would appear that Danby intended to have a "Botany Professor" also, but the Civil War broke out and funds were short. Morison, first professor, was not appointed until 1669 (*obit.* 1683).

The shortage of funds forced Bobart to support the Garden on what he could grow in it. There is in the archives a rather pathetic appeal (undated) to the Vice-Chancellor from Jacob Bobart jun., who succeeded his father, asking for a salary. He pointed out that the "Exoticks" he cultivated needed special care, and he thought it "a digression, to make Cairfax shine wth the spoils of the Physick Garden, allways haveing respect to the dignitie of the Universitie".

Bobart the younger died in 1719. The year before there had returned to England Dr. William Sherard, sometime fellow of St. John's, who had been consul at Smyrna. Sherard was a man of means with a considerable interest in botany. He regretted the state of neglect into which the Garden had fallen and entered into negotiations with the University to put botanical studies on a sounder footing. He had a remarkable library and an extensive herbarium. He proposed to found a chair of botany, with £3,000 endowment, nominating Dillenius, a distinguished botanist in his employ, as professor, and to leave his library and collections to the University, if the University would revive the Garden, erect the necessary greenhouses and library buildings, and make due provision for upkeep. The negotiations were protracted (Sherard mistrusted early eighteenth-century Oxford) and before they were completed he died (1728). A dispute arose between his executors and the University which dragged on for years, until it was finally settled by an award of Chancery on June 11, 1734. By it the University got the £3,000, the library and collections, and Dillenius became the first Sherardian professor. The University on its part erected the buildings, guaranteed £150 per annum for upkeep of the Garden and appointed a Perpetual Committee, consisting of the vice-chancellor, the proctors, and seven senior resident members on the "Physic Line" to see that the provisions of the award were carried out. The Royal College of Physicians was made visitor.

It is from this award in Chancery that the curators have derived their authority, and it would again become operative should the University at any time cease to maintain the Sherard collections under the custody of the Sherardian professor.

It is clear from the early minute book preserved in the archives of the Department that the Perpetual Committee took its duties lightly. It met once a year (with occasional omissions) to approve the accounts and appoint a head gardener. By the beginning of the nineteenth century the Garden had again fallen into a bad state. Its revival owes much to the energy and liberality of Daubeny, Sherardian professor during 1834–67. During his tenure of office the existing range of greenhouses took shape.

In course of time the importance of the Garden as a source of materia medica became less, and its value as part of the University's equipment for the wider study of botany increased. Members of the medical faculty, as such, had less interest in the Garden, and the constitution of the Perpetual Committee was changed (1871). In 1886 an order of the Court of Chancery established a Board of six elected curators, who were given the management of the Garden under the scheme drawn up in 1734. But the same scheme had given the Sherardian professor control of the gardener, as is recognized in the statutes defining his duties! Obviously there was need for clarification.

The new Statute, just adopted, makes the professor (at present, Prof. T. G. B. Osborn), *ex officio* a member of the Board of Curators and confirms his duties of 'charge and supervision'. The constitution of the Board remains otherwise unaltered, and the Board as a whole is responsible for the general policy and upkeep of the Garden from the funds which it receives.

In June, 1942, Mr. W. G. Baker, who had been head gardener for more than fifty years, retired, and by good fortune the curators secured the services of Mr. G. W. Robinson, formerly superintendent of Chelsea Physic Garden, to succeed him. With his skill and experience the Garden should thrive and develop.

If by further good fortune some graduate of Oxford should be moved to give to the Oxford Garden only a part of what Cory recently bequeathed to the younger Botanic Garden at Cambridge (see NATURE of March 20, p. 328), then indeed the future of the oldest botanic garden in Great Britain would be assured.

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* Substance of an article in the *Oxford Magazine* of March 11, 1943.

ASPECTS OF PHOTOMICROGRAPHY

A SYMPOSIUM on photomicrography was arranged by the Scientific and Technical Group of the Royal Photographic Society and took place at the Society's premises on the afternoon of February 20.

Mr. F. Martin Duncan opened the symposium with a general description of the applications of photomicrography to biological research. He stressed that much good work may be done by means of comparatively simple home-made apparatus. He illustrated the type of equipment he uses for low-, medium- and high-power photomicrography, and dealt with the particular requirements and difficulties of each branch in turn. For low-power work with living specimens a long-extension camera with a short-focus lens is used; it should be mounted on a rigid stand with the axis vertical. The need for rigidity increases with the magnification. For medium powers the camera is fitted to the end of a microscope tube, and for high-power work at a thousand diameters or more a well-made box camera can be used. For critical work, centring the microscope is most important. Not only should a centring substage condenser be used, but it is also advisable that each objective should be capable of being centred with respect to the remaining lenses in the optical system of the microscope. Most of the double and triple nosepieces sold give unsatisfactory centring of the objectives and cannot be recommended.

Some slides were projected to demonstrate the correct use of filters and choice of negative material, showing the difference in rendering of tone and detail which may be attained by such means. Infra-red technique can sometimes be used with advantage to reveal fine detail in structures that appear dark and opaque in ordinary light. Examples were shown of certain coal specimens, beetles and fleas. In one case the infra-red photograph revealed the presence of some minute parasites on the fleas themselves. The paper was illustrated throughout by a large number of photomicrographs of various subjects of general interest.

Dr. V. G. W. Harrison said that in investigating alloys one of the first tasks is to establish, at all events approximately, the constitution diagram of the system. The means available include the determination of arrest points on cooling curves, thermal dilation curves, magnetic permeability curves, X-ray analysis and photomicrography. None of these is infallible alone, but taken together they are a powerful combination. Dr. Harrison said that his own work has been devoted mainly to the metallography of nickel-iron alloys, which are particularly interesting because the meteoric nickel-irons have a peculiar structure which cannot be reproduced under terrestrial conditions.

Metal specimens can rarely be cut so thin that they transmit light; thus they usually have to be examined under vertical illumination. A specimen is first cut with a hacksaw; one face is filed flat and then rubbed down on successively finer grades of emery. The aim is to finish with a plane mirror-like surface free from scratches and flow marks. There is no royal road to this; care and patience are more important than the exact materials used. The finer grades of commercial emery paper are, however, of little use on account of the grit in them, and better results are obtained by grading 'flour' emery powder oneself and using it wet on an ordinary cork household knife-board. The final polishing is done on a rotating cloth-covered wheel fed with a suspension of a polishing material such as rouge or alumina; chromic oxide gives good results. The surface so prepared is not characteristic of the alloy since it has undergone a certain amount of cold working, and to reveal the true structure of the alloy this layer has to be removed. This is usually accomplished by etching. The etchant used varies according to the chemical nature and physical state of the alloy and the constituents or structure which it is particularly desired to examine. For 10 per cent nickel nickel-iron alloys, 5 per cent nitric acid in water is suitable for most purposes. The depth of etching has to be learnt by experience. Too little etching fails to remove the cold-worked layer and gives poor contrast; too much etching throws the structure into relief and makes focusing difficult in high-power work.

When examined by vertical illumination, constituents that are little attacked by the etchant retain their mirror-like surface and appear bright; the others are dark. Photographically, the images may usually be treated as black-and-white subjects; nothing looks worse than a section represented in the print by pale washy greys and dirty whites. For this work a medium-speed orthochromatic plate which will stand development to high contrast without fogging is generally suitable. Most of the photographs were taken with apochromatic objectives and light filtered through a blue 'narrow band' filter.

Slides were shown to illustrate some of the changes in structure which occur when natural and artificial nickel-iron alloys are subjected to heat treatment, and it was explained briefly how these visible changes can be correlated with changes in physical properties due to phase changes within the alloy.

Dr. L. C. Martin continued the symposium with an account of the optics of photomicrography. Photomicrography at low magnifications with a field of, say, 18° requires a lens of 'photographic' type, for example, of 2 in. focal length and 'aperture' $F/4 \cdot 5$. Such a lens may be used for magnifications up to about 35 diameters, if long working distances are no drawback. Ordinary microscope objectives may also be used. The field is then restricted to 6°–8°, but the aperture may be greater and the definition better. For magnifications of 20 and upwards it is convenient to use a compound microscope. A well-made projection eyepiece does not cause any deterioration in the image yielded by the objective, at least in the centre of the field.

The magnification to be employed depends upon the fineness of detail and the circumstances in which the print is to be viewed. The separation of fine lines such as pearlite will be apparent at a distance between them of 0·2 mm., but this can be brought up to 1·0 mm. with advantage: this entails a magnification of 1,600–3,000 diameters. In general, to show the greatest amount of detail the magnification should be about a thousand times the numerical aperture of the objective. Magnifications higher than this will not reveal fresh detail; the use of lower magnifications may mean that some details escape observation. Greater numerical aperture means better illumination and more detail; but also a more restricted field of good definition and less depth of focus, which is a disadvantage when thick sections are being examined. For routine work it is a good plan to use no greater numerical aperture than is necessary.

Much depends upon the illumination of the object. A great variety of arrangement is possible for opaque objects. For transparent objects, both dark ground and ordinary bright field illumination may be employed. Dark-ground pictures are attractive but more difficult to interpret than those taken with the light field. If the object to be viewed by transmitted light is a narrow opaque strip, the sharpest picture of the boundaries may be obtained in two ways. One can use a broad source of light, such as a window or opal lamp. The disadvantages of this are that the illumination may not be intense enough for photomicrography, and stray light may spoil the image. The latter may be avoided by using a diaphragm. Alternatively, a lens system is made to form an image of the effective source of light in the plane of the object. The angle of convergence of the rays produced by the lens must be as great as the divergence required to fill the aperture of the objective. Dr. Martin then described two optical expedients suitable for cases in which the size of the image of the source is not sufficient to illuminate the required area of the object slide. He stressed that one should never let more light into the system than is required for the illumination of the minimum necessary area of the object field and for filling the aperture of the objective. In order to control the light, the source and lenses must be correctly aligned.

For transparent objects, when the visibility is due merely to a change of refractive index, the boundary of change may appear dark in the picture unless the aperture of the condenser is reduced. Usually a reduction of the illuminated aperture of the objective to a diameter of about two thirds the full amount is suitable.

Mr. F. J. Pittock concluded the symposium by dealing with the practical application of colour filters to the recording of the image of microscopic specimens by transmitted light. The use of colour filters must take into account not only the colour of the microscopical preparation, but also the relative densities of regions of the same preparation. In the days before the introduction of panchromatic material, the illuminants used were of great intensity and a cooling bath containing a coloured solution had to be introduced to absorb the heat and reduce the brilliance of the light. Other dimming devices were ground glass and 'signal green' glass. It has been known for many years that the resolving power of objectives is much increased if blue or green monochromatic light is used.

Though neutral density filters of colloidal carbon or silver grain cannot be classed as colour filters, they should form part of the equipment of all photomicrographers. Two filters, reducing the intensity one tenth and one hundredth respectively, are recommended for general purposes. There are two reasons for the employment of colour filters proper: first, the resolution is often improved by the use of approximately monochromatic light; secondly, it is usually important that the photomicrograph should show certain areas with greater contrast than is given by differential staining or the density or texture of the material under consideration. By using monochromatic light, chromatic aberration of the lenses is eliminated.

Mr. Pittock exhibited photomicrographs of the developing eye of a pig embryo stained with borax-carmine. On an ordinary plate without filter, the screen sharpness was never faithfully reproduced, whatever the quality of the objective. Exposures on orthochromatic process and panchromatic process plates showed progressive improvement. The introduction of a green filter gave further improvement, and the best result was obtained with the combination of green filter and panchromatic plate. The speed of the plate is generally of little consequence, and a slow plate is therefore preferred because of its superior resolving power.

The question of what is meant by 'contrast' in photomicrography is difficult to answer. Generally, some less important detail has to be suppressed by the use of appropriate filters to give clearer expression to the points of main interest. That is, contrast is reduced in one region and increased in another. If specimens are transparent, this fact should be obvious in the photomicrograph; it is undesirable to give the effect of an opaque mass without internal detail against a white background. Mr. Pittock showed photomicrographs of a section of spruce fir stained green and counterstained red, and explained the difference in appearance produced by the use of blue-green and orange-red filters respectively. The best filters for use with some well-known stains and counterstains were next discussed. Certain structures are commonly revealed in sections after impregnation with silver salts followed by weak development in a reducing solution. Specimens so made are dark brown or black in colour, semi-opaque and need an orange filter, or even infra-red technique. It is not generally realized that silver-impregnated specimens are amenable to further treatment by any of the colour toning methods recommended for lantern slide-making, with an appreciable increase in transparency.

When objectives giving the utmost resolving power at high magnifications are used to reveal the fine cytological detail of stained sections, the best results are obtained with blue-violet filters and ordinary or ortho-process plates. This was demonstrated by photomicrographs of the pituitary body by yellow-green and by blue light. Mr. Pittock concluded by giving some technical details of the exposure and development of the various photographic plates used.

The papers presented at the symposium will be published in due course in the *Photographic Journal*.

V. G. W. HARRISON.

A GRAIN-BORNE DISEASE OF BARLEY

THE incorporation of barley in bread as a war-time expedient gives added interest to a recent study of the host-parasite relationships of this cereal and *Helminthosporium sativum* P., K. and B. (Mead, H. W., *Canad. J. Res.*, 20, 501; 1942).

Infected barley grains usually show a pale to dark brown discoloration of the adhering lemma and palea. The cells of the host react to penetration by the formation of callosities, and those invaded, either singly or in groups, die and become discoloured, although hyphæ may also be present without discoloration. Hyphæ may also be present in the cells of the pericarp, and thick-walled resting mycelium may be found on the surface of the tissues or in the intercellular spaces. Many samples have been observed to contain as high as 38 per cent blighted kernels. When the grain is planted the mycelium renews its growth and may infect other cells or form conidiophores. Although mycelium from infected grains may spread through the soil for as much as 2·5 cm., this probably plays little or no part in the infection of seedlings.

At germination, the plumule and the radicle are in contact with the lemma, palea, lodicules and pericarp, any or all of which may be diseased, with the result that infection of the seedling often occurs at the base of the plumule and the radicle. Seedlings usually reach a degree of development because the fungus takes some little time to penetrate to the growing point.

Inoculation of the heads at or immediately after flowering results in the death of the ovaries or the production of only small grains with non-viable embryos. Hyphæ may be found as deep as the cells of the inner layer of the pericarp, but they do not seem to penetrate beyond this. Infection 7–10 days after flowering leads to the invasion of the pericarp tissues and the production of shrunken and discoloured kernels, although as microtome sections show, the inner integument, aleurone layer, endosperm and embryo are free from mycelium. Infection 15–20 days after flowering results in the invasion of the lemma and palea, but the pericarp has mycelium mainly in and on the surface at both ends of the grain, where it is not protected by the lemma and palea, which are now becoming fused with it. Only a little is found on the central portions of the dorsal and ventral surfaces. Such grains are as plump or plumper than non-infected ones.

When diseased grains are planted, severity of infection may express itself in any of five degrees: (1) lack of germination due to the blight of the plumule and radicle at a very early stage, (2) early blight of the still unemerged shoot with infection spreading to the emerged roots, (3) post emergence blight of the shoots and roots, (4) stunting of the seedlings, (5) superficial lesioning of the seedling.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk is open to the public*)

Saturday, March 27

Biochemical Society (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 2 p.m.—Annual General Meeting.

Sunday, March 28

South Place Ethical Society (at Conway Hall, Red Lion Square, London, W.C.1), at 11 a.m.—Sir Richard Gregory, Bart., F.R.S.: "Education in World Ethics and Science" (Conway Memorial Lecture).

Tuesday, March 30

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir Henry Dale, G.B.E., P.R.S.: "Chemistry in Modern Medicinal Treatment". (iii) "The Beginning of Chemotherapy".*

Wednesday, March 31

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. R. E. Slade: "The Chemical Attack upon Pests".

Thursday, April 1

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Sound Films of Honorary Members and Faraday Medallists—Sir Ambrose Fleming, F.R.S., and Dr. A. E. Kennelly.

Friday, April 2

Royal Society of Arts (Joint Meeting of the India and Burma Section with the East India Association) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir David Meek: "Post-War Industry in India".

Royal College of Surgeons of England (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Sir Hugh Lett, Bart.: "Anatomy at the Barber-Surgeons' Hall" (Thomas Vicary Lecture).

Association of Scientific Workers (Harpenden Branch) (in the Congregational Hall, Harpenden), at 5 p.m.—Mr. A. L. Bacharach: "World Agriculture and Man's Nutritional Needs", 2: "The Scientific Measurement of Human Food Requirements".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—A programme of Scientific Films.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chair of Chemistry in the University College of North Wales—The Bursar and Acting Registrar, University College of North Wales, Bangor (April 3).

Senior Assistant Master (principal subjects: Mathematics and Science, particularly Elementary Biology) in the English School, Nicosia, Cyprus—The Secretary (I.P.R./CA), Board of Education, Belgrave Square, London, S.W.1 (April 5).

Educational Psychologist (man or woman)—The Director of Education, Education Offices, Leeds 1 (April 7).

Lecturer (woman) in Science (Biology and General Elementary Science)—The Principal, St. Charles's R.C. Residential Women's College (London), at St. Gabriel's, Coldash, Berks. (April 10).

Borough Electrical Engineer and Manager—The Town Clerk, Town Hall, Keighley (endorsed 'Borough Electrical Engineer and Manager') (April 10).

Laboratory Superintendent for the Medical Department, Government of Nigeria—The Secretary, Overseas Manpower Committee (Ref. 746), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

Teacher of Engineering Subjects, and a Teacher of Building Construction and Allied Subjects in the Rotherham College of Technology and Art—The Director of Education, Education Offices, Rotherham.

Laboratory Assistant (man or woman) for the Physics Department of the London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1—The Warden and Secretary, Reed Hall, Streatham Drive, Exeter.

Education Lecturer, with good qualifications and experience, particularly in methods of teaching Arithmetic and Elementary Mathematics—The Registrar, Municipal College, Portsmouth.

Engineer to a Catchment Board in the North-East of England—The Ministry of Labour and National Service, E.609.X., Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh, Section B (Biology). Vol. 61, Part 4, No. 27: The Larval Maxilliary Glands of *Euphausia superba* Dana. By M. V. Schorstein. Pp. 375–384. 9*d*. Vol. 61, Part 4, No. 28: Hybrid Sterility in Artificially Produced Recombinants between *Drosophila melanogaster* and *D. simulans*. By G. Pontecorvo. Pp. 385–397. 1*s*. (Edinburgh and London: Oliver and Boyd.) [82

Imperial Forestry Institute: University of Oxford. Eighteenth Annual Report, 1941–42. Pp. 12. (Oxford: Imperial Forestry Institute.) [82

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 13: Limestones of Scotland, Area 2: West-Central Scotland. By Dr. J. B. Simpson; with Contributions by Dr. M. Macgregor and Dr. T. Robertson, and Analyses by Dr. A. Muir and H. G. M. Hardie. Pp. 30. (London: Geological Survey and Museum.) 1*s*. 6*d*. [82

Institution of Heating and Ventilating Engineers. Tables of Hygrometric Data for Air Conditioning Calculations. Pp. 76. (London: Institution of Heating and Ventilating Engineers.) 2*s*. 9*d*. [82

Sheffield City Libraries. Research Bulletin No. 7: Management and Labour. Pp. 46. (Sheffield: Central Library.) 3*d*. [102

Committee of the Privy Council for the Organisation and Development of Agricultural Research. Agricultural Research in Great Britain. Pp. 100. (London: H.M. Stationery Office.) [102

Report on the Phenological Observations in the British Isles from December 1941 to November 1942. By Major H. C. Gunton. (Quarterly Journal of the Royal Meteorological Society, Vol. 69, No. 299.) Pp. 32. (London: Royal Meteorological Society.) 3*s*. [112

Eire: Roinn Talmhaidheachta (Department of Agriculture), Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1941, 1939, 1937, 1935, 1933, 1931, 1929, 1927. (P. No. 5698.) Pp. 19. (Dublin: Stationery Office.) 6*d*. [152

London School of Hygiene and Tropical Medicine. Report on the Work of the School for the Year 1941–42. Pp. 43. (London: London School of Hygiene and Tropical Medicine.) [182

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 13: *Argyresthia conjugella*, Zell., and other Lepidopterous Pests in Ireland during 1942. By Dr. Bryan P. Beirne. Pp. 163–172. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [182

Carnegie Trust for the Universities of Scotland. Forty-first Annual Report (for the Year 1941–42) submitted by the Executive Committee to the Trustees on 15th February 1943. Pp. iv+68. (Edinburgh: Carnegie Trust for the Universities of Scotland.) [182

University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor (D. T. A. Townend) for the Session 1941–1942. Pp. 16. (Leeds: The University.) [192

Other Countries

U.S. Office of Education: Federal Security Agency. Health Services in City Schools. By Dr. James Frederick Rogers. (Biennial Survey of Education in the United States 1938–40, Vol. 1, Chapter 5.) Pp. iii+50. (Washington, D.C.: Government Printing Office.) 15 cents. [291

Carnegie Corporation of New York. Report of the President, the Secretary and the Treasurer for the Year ended September 30, 1942. Pp. 125. (New York: Carnegie Corporation of New York.) [82

Bulletin of the Auckland Institute and Museum. No. 2: The New Zealand Recent and Fossil Mollusca of the Family Turridæ; with General Notes on Turrid Nomenclature and Systematics. By A. W. B. Powell. Pp. 192+14 plates. (Auckland: Auckland Institute and Museum.) [112

Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Nineteenth Annual Report, 1942. Pp. 6. (Boston, Mass.: Ella Sachs Plötz Foundation, c/o Massachusetts General Hospital.) [152

Smithsonian Miscellaneous Collections. Vol. 103, No. 1: Distribution and Variation of the Hawaiian Tree Snail *Achatinella apexfulva* Dixon in the Koolau Range, Oahu. By d'Alté A. Welch. (Publication 3684.) Pp. ii+236+12 plates. (Washington, D.C.: Smithsonian Institution.) [152

Bulletin of the American Museum of Natural History, Vol. 80, Art. 9: Results of the Archbold Expeditions, No. 48: Pteropodidæ (Chiroptera) of the Archbold Collections. By G. H. H. Tate. Pp. 331–348. Vol. 81, Art. 1: The Vernay Collection of Cretaceous (Albian) Ammonites from Angola. By Otto Haas. Pp. 224+47 plates. (New York: American Museum of Natural History.) [172

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NATURE

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WAR-TIME CONSUMPTION AND RATIONING

TO the ordinary citizen, control and rationing are methods of maintaining equal division of limited supplies at reasonable prices ; to the economist, considering the diversion of the maximum fraction of the national income to the purposes of war, they are methods of reducing civilian consumption ; to the statesman they are a bit of both, with the maintenance of health and morale thrown in. The first chapter of the Report of the Economic Intelligence Service of the League of Nations considers the means by which civilian consumption can be reduced*. The last gives some idea of the effects of this reduction ; in Great Britain the reduction of consumption provides 25 per cent of the war effort. In the intermediate chapters details are given of direct rationing in force in various countries.

The severity of the rationing of clothes varies. In Great Britain a man can get a woollen overcoat, a suit and a pair of shoes with one year's coupons. In Germany an overcoat requires more than one year's coupons and an overcoat and suit more than two. To obtain scarce goods (shoes and items containing a high proportion of wool, linen and cotton) a consumer in Germany has to prove his need for the articles. Non-perishable goods, such as vacuum cleaners and refrigerators, are durable and therefore not suitable for rationing. Consequently, their production has been cut down or stopped altogether. Until recently, this was the chief method by which consumption was limited in the United States. Food, drink and tobacco accounted for more than forty per cent of consumers' expenditure in Great Britain before the War ; reduction of food consumption outside narrow limits has a serious effect on morale and health.

It is natural that the greater part of the report should be taken up with food rationing. The rations of twenty-one European countries are tabulated.

The food supply in Great Britain is much better than in any other belligerent country in Europe or in most of the neutral and occupied countries. Only in Great Britain, Switzerland, Eire and Portugal are bread and flour unrationed. Bread is rationed, but not potatoes, in Sweden, Denmark and, possibly, some other countries in eastern Europe. Meat is unrationed in Denmark and Eire ; the meat ration in Great Britain is considerably higher than in the remaining countries. No milk is allowed to the ordinary consumer in Belgium, France, Germany, Holland, Norway and Poland. Heavy workers in Germany and workers in Britain who can eat in Class A canteens get double rations of meat and 50 per cent extra fat ; but as the basic rations are higher in Great Britain, the British worker (provided that he has a canteen to go to) has the advantage.

The report draws a contrast between the flexibility of the British system and the rigidity of the German. In Germany, rations are fixed to allow for the needs of several different categories: children divided according to three age periods, three classes of workers. This difference of system is, however, merely a reflection of the difference of level of food supply in the two countries. In Great Britain we are still allowed to eat as much bread and flour as we want; there is no need to make special provision for those who expend extra energy. But, in Germany, the supply is not enough to meet the appetite, and the prior claims of manual workers and growing children are recognized; if the 'elastic' British system were introduced, the consumption would go up. It is good fortune, not judgment, that gives us the less rigid system. In Great Britain about 20 per cent more bread was eaten in 1941 than before the War. In those countries that ration bread and potatoes (which supply 40–70 per cent of the total energy of the diet) the calories derived from these two foodstuffs have gone down by 20–60 per cent.

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* League of Nations : Economic Intelligence Service. Wartime Rationing and Consumption. (Publication 1942, II, A.2.) Pp. 87. (Geneva : League of Nations ; London : George Allen and Unwin, Ltd., 1942.) 3s. 6d.

In nine countries the foods that provide more than 90 per cent of the calories of the normal diets are rationed. As it is not possible to increase the energy value of the diet appreciably by expanding the consumption of the unrationed foods, a fair estimate can be formed of the total calorie value of the diet in these nine countries. The weighted average works out at 1,220 calories per head. In most of these countries the rations of children, down to six years old, are the same as those of adults. In the report, the number of calories per 'consumption unit' are calculated on the assumption that a typical family consists of man, wife and three children less than ten years old. However, the ratio of young children to adults is nowhere as high as this, and the calculations give a misleading estimate of the level of consumption by adults. Even in the early part of 1942 the normal consumers' rations of bread and flour in Germany were as low as in Berlin in September 1918 and the potato ration lower; the situation in Europe, as a whole, was at least as bad as in Germany at the end of that year. Also rations were cut down considerably between 1941 and 1942. As the chief cause of shortage of food on the Continent is reduction of the productivity of the soil it is probable that the shortage will become steadily worse. We may not be justified in prophesying the date of collapse of the Nazis; the extra rations of manual workers will do something to delay this, but we can be sure that, when that collapse occurs, want in Europe will be extreme. For the present we can do little to help our friends. The amount of grain allowed into Greece is a very small fraction of the amounts imported before the War, and the proposed allowance of relief for Belgium would supply only one ounce of dried milk per day to some two million children, pregnant and nursing women and invalids.

In due course the Allied troops will drive the Axis forces back through Europe. We are pledged to bring food with our armies. As it is, we have difficulties in maintaining the level of our own food supply. The Nazis will have cleared all stocks of food out of the liberated countries. We may find that we have millions of destitute people to feed while greater demands are made on our shipping for the transport of troops and supplies. Hundreds of millions of people in Europe will not be liberated until the Nazis are finally defeated. They will then need relief on a scale larger than in 1919. Two problems are inevitable: to find sufficient shipping to carry the necessary cereals and to find stocks of animal foods. To solve these problems it will be necessary to continue the control of production, transport and consumption until the economy of Europe is well on the way to recovery.

Will the need end when that time comes? The League of Nations Report suggests that rationing systems indicate the rise of a consumer's economy: "in spite of the necessary limitations imposed by war-time scarcity they contain the elements of a system in which consumption is guided, not so much by individual purchasing power, as by human wants". Such a consumer's economy is foreshadowed in the Atlantic Charter and the Four Freedoms of President Roosevelt; and more specifically in the Beveridge Report, in its unmutilated form. "Thus, the study of wartime consumption and rationing is relevant to the problems of the future."

POLITICAL AND ECONOMIC PLANNING

LONG before the outbreak of war, the body known as PEP (Political and Economic Planning) had established its reputation among fact-finding organizations studying the economic and social problems of modern society. Probably no other body in Great Britain has done quite so much to prove the possibility of an impartial approach to many large questions of social organization. There is nothing new in the contention that policy should be the outcome of research and knowledge. That has been urged by scientific workers for years. It is the core of their present criticism of the use of science by the Government in furtherance of the war effort, and it lies at the root of their claim that the scientific worker should not be debarred from administrative positions on the ground of his scientific qualifications when he shows that he possesses the requisite administrative ability.

The measure of the success of the PEP effort during the last twelve years, which has recently been reviewed in the two hundredth issue of its broadsheet, is shown in the extent to which collaboration has been made practicable over a wider territory in the social sciences among men and women of different political views, and also in the greater readiness to accept the discipline of inquiry and to follow the argument where it leads. The growing impatience at Government inaction over recent reports dealing with industrial and social reconstruction indeed testifies that there is now in Great Britain a much more general disposition to regard such methods of impartial inquiry and experiment as applicable in current matters of public concern and as the correct basis for policy, rather than political theories or party programmes.

Important as is this tendency, the system of group consultation and investigation represented by Political and Economic Planning has a further advantage. It facilitates the pooling by specialists of their intellectual resources with those of their peers in other departments of study or knowledge, thereby fostering the creative thought which is our greatest need, and minimizing the risk that the services of the expert will not be invited or employed.

No one can read the brief summary of P E P activities set forth in this two hundredth broadsheet without realizing the wide range of problems, and the ramifications which call for the services of those who possess technical knowledge in every social or political plan. No schemes for reconstruction can hope for success in which this problem of securing the full contribution which the technical, scientific and other professional experts have to make collectively to social progress finds no solution. Unless that influence can be made effective, within the framework of a democratic system, on affairs that hitherto have been dominated by political parties, capital or labour, our hopes of progress are slight.

The leading ideas in the P E P approach are admirably set forth in the introductory paragraphs of the present report. Starting with emphasis on the value of the fact-finding attitude, the broadsheet points out that social measures are often impeded in our complex society, not so much by technical as by psychological obstacles arising out of ignorance, and these obstacles may often be removed by an impartial statement of the facts. A further fundamental aim of P E P has been to offset the sectionalism and specialization of modern society, which is so often the enemy of planning, by giving members of the general public, the administrator, the technician and the professional man or woman an opportunity to contribute, according to his capacity, to the solution of social and economic problems. By classifying problems to establish similarity or sequence, and by emphasizing, in tackling successive problems, patterns of ideas, the broadsheets have sought to forge a link between the social and economic organism of a technical age and Parliament or the Press.

In stressing the need for planning as an instrument for coping with the problems of a modern society and the failure of *laisser-faire*, P E P has always recognized that planning is no panacea. It has regarded itself as the exponent of a particular type of planning —the working together of a number of organizations for some consciously accepted end. Such evolutionary planning is regarded as the only means of escape from the intolerable restrictions upon individual liberty and freedom of choice which has resulted from the political and economic developments of recent years. The frank appeal which this broadsheet makes to those who are genuinely concerned at the outlook for liberty to set to work thinking and discussing how planning can be made the vehicle instead of the enemy of liberty is one which scientific workers especially should heed, and provides the right perspective in which to view, for example, the recent debates on the Beveridge Report. Success in evolutionary planning depends on the education of public opinion.

The investigations which P E P has conducted in particular fields, such as the productive apparatus, including industrial organization and the safeguarding of the public, industrial relations, agriculture, the planning of the use of land, the machinery of government, or of the social services, including retirement and education, nutrition and health, and again in the international field, such as international trade, where since the War P E P has revised its former decision to concentrate on domestic problems, have received notice from time to time in these columns. While in this way P E P's achievements may be familiar to scientific workers, its methods may be less generally known. P E P's main concern has been in the first place with the world outside the institutions of learning, and without discounting the fertilizing influence of theory, it is this world of experience that P E P has mainly attempted to tap. That there are now hundreds of organizations carrying out such investigations, whereas in 1931 only a few people were engaged in research of this kind, is clear evidence that the methods of practical research and group working that have been developed are of recognized value both in Britain and overseas.

Research is inevitably more complex in the social sciences than in the natural sciences. New techniques are required, of which this method of group research is one. The value of attaching a research secretary to discussion groups and of guiding research more fruitfully by the continued criticism of practical men and women have been demonstrated. Personal harmony and faith in the fact-finding approach are essential among the members of groups, and the best results have been achieved where members combine mastery of their subjects with a wide vision. A small number of laymen are usually members of each group, and outside experts have always been available for consultation. The executive committee watches the work of the individual groups and relates such work to the broad programme of P E P. The principle of anonymity is strictly preserved throughout.

There can be no two opinions as to the ability with which the P E P reports and broadsheets have laid clear the basic principles upon which decisions should be taken, and the directions in which further thinking and research are required as bases for policy.

The success already achieved not only entitles Political and Economic Planning to the goodwill and support of scientific workers in the future, but should also stimulate a wider and fuller contribution from them in the use of a technique of proved efficiency. We should not, indeed, make the mistake of assuming that the method is destined to eliminate Party politics. It may well assist in a new and more rational alignment of Parties and, by clarifying the issues and educating the electorate, give new vitality to the fundamental principles of representation and responsibility which a decade and a half of national or coalition government has overlaid, to the grave danger of democratic institutions. The fact that most of the tasks—social, economic and financial—before the nation are tasks of sheer organization which are eminently susceptible of the scientific and practicable approach must not lead us to forget that in a democracy the action required to execute a policy must come from those to whom responsibility has been entrusted by representative institutions, and who are prepared at any moment to give way to others charged in like manner with the same responsibility.

WORLD REORGANIZATION

Phœnix

A Summary of the Inescapable Conditions of World Reorganization. By H. G. Wells. Pp. 192. (London: Martin Secker and Warburg, Ltd., 1942.) 8*s*. net.

WHETHER it be only an expression of the lust of the human race to live, or whether it be a rationalization of the mass of actual happenings of our times, the notion of the persistence of society is taken for granted by the great majority of us. The threat to civilization which the present upheaval is so often supposed to represent leaves most of us rather 'cold'. All the same, if we succeed in shaking ourselves out of that state of mental inertia to which, as a nation, we are specially prone, we see clearly enough that, when we emerge from this hurly-burly, we have but two alternatives before us: either we drift once more into a state of *laisser-faire*, 'lose the peace' and await the next cataclysm, or we organize on a world basis so as to make war impossible.

"Phœnix" presents us with "a summary of the inescapable conditions of world reorganization". We judge from the manner in which the conditions are presented that the author, despite his careful distinction between his hope and his faith, believes in the practicability of such re-organization and therefore in an escape from a further, and even more terrible, disaster. "There is good reason," he says, "for concluding that a rational reconstruction of the world . . . can still be attempted." Does the reader ask how? The author reiterates the imperatives which a world revolution must obey: the establishment of an overriding federal world control of transport and inter-State communications, the federal conservation of world resources of all the federated States in accordance with a common fundamental law.

Having thus enunciated his imperatives clearly, the author, in true Wellsian fashion, takes the reader round his project "to view it from this point of view and that" in a series of interpolations which deal with the history of war, human temperaments and the place of money in the economic life. In the second part of the book the author returns to his aspects of the world revolution. He makes it clear that he is not thinking in terms of "bloody revolution" and an initial reign of terror. The Wells revolution is "the transformation of a going concern and not a fresh start". Revolution in the "bloody" sense is the antithesis of economy. "The institutions of to-morrow cannot be anything else than a clarified and emancipated adaptation of the institutions of to-day." The world revolution is a transformation by release. And again: "The . . . revolutionary movement can develop . . . at the higher level of the Open Conspiracy and the Candid Life." And there are things to be done *now*; we must not wait until armistice is declared, or, if armistice be not the order of the day, until the moment of unconditional surrender. We must make the most strenuous efforts to reappropriate the material that has been socialized for greater collective efficiency during the War.

But as to the foundation of this reconstruction there is no attempt to escape the issue. "The fundamental issue of the world conflict is the banishment of mastery and ownership from the whole world." The citizen (in Great Britain at all events) must be a Party politician rather than a mere patriot and must throw his weight to the left. As for "federal super-government", we must sweep the idea to the winds; quite effective machinery would be provided by special commissions to deal with settlements needed for the winding up of the War. These may be stretched out to become the effective administrative organizations of the world's affairs. We must aim at a system of federally co-operative world authorities with powers delegated to them by the existing Governments. And the ultimate pattern of society to be aimed at? It cannot be, and it need not be, clearly predicted, but it may well be something larger and more satisfactory than hitherto achieved, even by equalitarian Soviet Russia, from the economic life of which ownership has been lifted. Soviet Russia is still crudely experimental, exhibiting an extreme ideological intolerance; that draft no one should wish to stereotype. As for the Communist party in the West, it is "a yelping intervention and not an intermediary for the expansion of a common understanding".

So much for the imperatives of the world revolution, and so much for the machinery by which this revolution is to be effected. What of the personnel necessary for organizing its unity and its convergent activities? What of the individuals upon whose selfless and determined efforts the attainment of the desideratum depends? The author's answer lies in the Sankey Declaration of the Rights of Man, the universal acceptance of which is the paramount *sine qua non* for success. These "Rights" are the propaganda for the educational organization of the new world.

Mackenzie King recently expressed the view that if the new world order is not already on its way before the War is over, we may look for it in vain. This belief finds acceptance with the author of "Phœnix", as it does with many of us. To the question "Can science save civilization?" the answer surely is, No. The salvation of society can only come through a change of heart in society itself. "The Kingdom of Heaven is within you." But as to whether there are enough men of good will to go round and to stand as a bulwark against the efforts that will certainly be made to force the world back into the slough of pre-war apathy, our seer gives no answer. How can he? He has, in this book, performed the prophet's major task—he has stabbed our spirit wide awake. He has shown us clearly the inescapability of our position and he has also shown us what is necessary for our successful emergence from it.

In the presence of so weighty (to many of us) and so convincing an argument it is perhaps trivial to complain about the interruptions that tend to weaken its cogency. The reader surely knows his Wells sufficiently by now not to have his attention distracted unduly by digressions upon "why Generals deteriorate", "temperamental types" and "love in a new world". An edited Wells is unthinkable, and the reader can deal with these chapters separately. If he cannot, then he should forgive them to the man who writes such illuminating chapters as those on "re-education", "the protection of the consumer" and "the lay-out of the reorganized world". Both people and the individuals get the rough side of the author's tongue now and again. Indeed, there are few, or no, soft words for anyone. To that also the reader is not unaccustomed. But the subject is a stark one and frills are, anyway, inappropriate. "Phœnix" lays bare for us our categorical imperative.

Horder.

ARABIA FELIX

In the High Yemen

By Dr. Hugh Scott. Pp. xix+260+115 plates. (London: John Murray, 1942.) 18s. net.

Ever since Niebuhr's remarkable scientific expedition to the Yemen in 1762–63, it has been recognized that to the biologist South-West Arabia holds a geographical position of great importance for questions relating to plant and animal distribution. For its varied and still largely unexplored confines, ranging from mountainous high altitudes with temperate conditions and abundant rain, to the tropical heat of the lower levels and coastal regions, are the meeting place and areas of overlap of the three great biogeographical regions: that of the Northern, the Oriental and the Ethiopian. Moreover, even now, nearing two hundred years since the plant collections of Niebuhr's botanist, Forskål, were made, published and finally reached the British Museum, the region has been so little investigated owing to political difficulty of access that Dr. Scott, in his most interesting book, can write of the 600-odd plants collected on his expedition that "in many cases no examples of these species from Arabia were received at the Museum from that time until we brought home fresh material in 1938".

The quest of Dr. Scott and his colleague Mr. Everard Britton, prolific though it proved in other incidental fields, was, however, primarily an entomological one; and in February 1941 appeared the first published instalment from the British Museum (Natural History) of the 27,000 insects they collected, which has already enriched science with new genera and many new species.

Dr. Scott is too good a naturalist to be content even in a generalized account of the expedition such as this book to omit scientific essentials underlying the wider aspects of the work. A succinct account is therefore given in Chapter 2 of the geological sequence of events in the region, leading up to the conclusion, "Though the separation of the South-West Arabian and Abyssinian highlands occurred after the remoter geological epochs, it took place quite long enough ago for some of the animals and plants on either side to have diverged in the course of evolution. We may therefore expect, and we do in certain cases find, closely related but slightly different representatives of the same groups on opposite sides of the Red Sea. Moreover the Red Sea rift has acted as a barrier to the distribution of some forms of life. For instance, the giant lobelias of the Tropical African mountains reach as far north as the Eritrean highlands, but are not found across the Red Sea in the Yemen. Conversely some European and Asiatic plants such as the iris reach as far as the Yemen but are not established on the African side. When our large collections have been studied in detail, it is hoped that a contribution will have been made towards solving these questions concerning the past history of this part of the earth, and the rate at which new species and varieties are evolved."

Scientific specialists mostly are, by nature and nurture, habitually observant people; and when, as in the case of Dr. Scott, this quality is combined with a sense of proportion it would be unfortunate, as is only too often the case, that the written record should be confined to the purely scientific results alone. This is doubly so in South Arabia, which has tended to become the 'copy' of now fairly numerous unofficial travellers, whose tales, ranging between extremes of gush or dislike, hold common ground in their disregard for objectivity.

Dr. Scott's book, a by-product of his real work, is a straightforward and quietly impersonal narrative of an expedition full both of diverse interest and thwarted hopes, in a setting of sometimes startling beauty, communicated to us in a long series of outstanding photographs. In particular the difficult panoramic snapshots, taken from stances on 8,000 or 9,000 ft. mountain tops, are descriptively magnificent. Wild-flower lovers, too, as well as wild-scenery lovers, will find alluring references to such flowers as pure white iris (which Dr. Scott suggests may have spread from its Mediterranean habitat owing to the Arab custom of planting it on graves), a yellow-blossomed lavender, orange gladiolus, and sweet white jasmine, as well as the homely wild rose and buttercup.

It had been the original intention to investigate especially the fauna and flora of altitudes above 9,000 ft. This programme was almost completely frustrated by the not unnatural suspicions of the Imam, of whom Dr. Scott writes with dispassionate understanding. Plans therefore had to be recast at Aden, and while permission even to enter the Yemen remained in suspense, an improvised, but in the event very profitable, expedition of some weeks was made in the freedom of the Amiri Highlands of the Western Aden Protectorate, mainly spent in camp on Jebel Jihaf at about 7,000 ft., or in the Wadi Tiban on the still forbidden Yemen frontier.

At an early stage in the narrative the present reviewer, remembering the unnecessary strain of the badly organized expedition to the Hadhramaut of which she was the archæological member, the same winter that Dr. Scott was in the Yemen, is filled with envy at the description of his three carefully chosen Somali servants, men of resource, ability and tact, who, moreover, spoke English as well as Arabic, and evidently eased many a trying situation, besides becoming valuable assistants in the work.

Finally, a grudging permit to enter the Yemen was obtained, and Dr. Scott and his colleague were enabled to spend three months in that near-forbidden land, though continually handicapped by strict surveillance, limitation of movement to specified areas, and refusal of permission to ascend mountains. Temporary escapes from the authorized paths enlivened the collecting. Maddening though such prohibitions must have been, Dr. Scott records much kindness and hospitality from the generality of Yemeni officials encountered; and in spite of all, much ground was really covered—such as the six-day journey from Ta'izz to San'a by the highland route, via Ibb and Yarim (where Forskål, who died there in 1763, probably from virulent malaria still prevalent, is buried), which has been traversed by less than half a dozen Englishmen.

Wherever he went, in town or countryside, Dr. Scott's powers of trained observation gathered harvests of diversified information scrupulously recounted. As a small example: his villagers sit, not under trees, but under fig, tamarisk or some other named tree; a seemingly trivial exactitude, but one which awakens in the memory of the reviewer the innumerable occasions in a Libyan desert oasis, when palæolithic man was found to have knapped his flints under the palæo-botanic remains of fig-trees preserved in travertines. 'Things', one might deduce, interest him more than 'people'; yet there is no lack of human interest, and a racy account is given of the strange State procession of the Imam in San'a in an ancient hooded State-coach drawn by four horses ridden by liveried postilions, preceded by his personal bodyguard of dancing foot-soldiers brandishing aloft their curved daggers; while behind followed his charger and an empty motor-car in case of need. An extra incongruity (to Western eyes alone) is added to the scene by the attendant who walked beside the coach whirling a gigantic 8-foot-wide umbrella.

In the final chapters Dr. Scott makes an audacious attempt to outline the still very speculative history, mainly undated, of ancient South Arabia. This is followed by a useful review of the more recent investigations on its racial composition by physical anthropologists. For this, owing to lack of published data by the Egyptian Expedition of 1936, led by Dr. Huzayyin, he has wisely drawn on Dr. Carleton Coon's "Races of Europe". The conclusions, which must be considered purely provisional until adequately long series of approximately dated ancient skulls have been obtained in controlled excavations, suggest to the reviewer a curious anthropological parallel to the biological situation which, as quoted above, has made South-West Arabia so valuable for evolutionary and distributional studies. For, inasmuch as Northern, Oriental and Ethiopian forms of fauna and flora find common ground there so, on the present findings (which are bound to be contested), does a branch of so-called Mediterranean man (that is, the typical brunettes of Nordic type on the high plateaux), Veddoid people (that is, with Ceylon Vedda affinities, mainly in the south and the Hadhramaut), and African negroids. The presence of other elements, including Jewish enclaves about which Dr. Scott gives interesting passages, adds complexity to an already over-complex question.

It is unfortunate that a delay of three years at the Oxford Press in the publication of the reviewer's results in the Hadhramaut should have introduced a small but not unimportant error in Dr. Scott's allusion to the short series of skulls there excavated. The evidence points towards a date of at least three or four centuries B.C., not, as stated, to the Christian era.

G. CATON-THOMPSON.

NATURE AND EARLY MAN IN IRELAND

The Irish Stone Age

Its Chronology, Development and Relationships. By Dr. Hallam L. Movius, Jr. Pp. xxiv+339+7 plates. (Cambridge: At the University Press, 1942.) 30s. net.

A MAJOR contribution to the advance of Irish archæology in the years before the War was made by the archæological expedition of the Harvard Irish Survey, directed by Dr. Hugh O'Neill Hencken, which between 1932 and 1936 excavated no less than fifteen ancient sites in Ireland, six of them—Kilgreany Cave in Co. Waterford and five sites in Northern Ireland—being of the Stone Age. These were excavated by Dr. Movius, assistant director of th expedition, and on that basis he has now, in thi admirably produced volume, given us the first comprehensive and systematic modern account of th Irish Stone Age cultures, and the chronology and character of their natural environment. Its importance i very far from being confined to Irish archæology. Th first part deals with the Late Glacial and Earl Post-Glacial chronology of all Northern and North Western Europe, and the second, in which the earlies known human settlement in Ireland is shown to b Mesolithic of the Boreal Period, perhaps nearer 700 than 6000 B.C., relates that settlement and its sequel not only to their local surroundings but also to th whole physiography and prehistory of the Britis Isles and the adjacent mainland. The book wil remain the standard work on its subject for a con siderable time to come.

Dr. Movius begins with a synoptic account of th recession of the last Pleistocene ice-sheet in Norther Europe and its Post-Glacial sequels, with thei accompaniments in human prehistory. He then set out to reduce to comparable order the publishe documents for the contemporary sequence in th British Isles. It is easy to see that he found the tw long chapters and six closely written appendixes o this the toughest part of his job. As a bibliographic study alone they are an achievement, but the resul is no mere compilation. It is a synthesis, in whic the stages of the recession from the 'New Drift' ic in Britain and Ireland are worked out and correlate with each other and with the established Balti sequence. With his introductory complaint of ou lack of a uniform nomenclature for glaciations man will sympathize; and though all will not like hi restriction of the term 'Old Drift' to the episode o the Upper Chalky Boulder-Clay of East Anglia an the Purple Drift of Yorkshire, this is understandabl enough in a context concerned less with that episod and its precursors than with its successo the 'New Drift' of Hunstanton and Hessle, wit which he equates the important end-moraine o Southern Ireland. The intervening Interstadia period (Würm 1/Würm 2) is that of Aurignacian ma in periglacial Britain; but, as is abundantly con firmed in the later chapter on "The Antiquity o Man in Ireland", neither at Kilgreany nor anywher else is there evidence of man's presence among th Late Glacial fauna of Ireland either then or in th final Upper Palæolithic stage represented by th British Creswellian culture.

The author recognizes that there has been tripl retreat from the 'New Drift' glaciation in bot islands. He correlates the main Ivernian ice-shee with the first period, its successor with the Scottis re-advance and Highland glaciation, and the thir that of the valley glaciation in Scotland, with th local glaciations of the Irish mountains. His co relations with Scandinavia equate these three wit the Daniglacial, Gotiglacial, and Finiglacial respe tively, so that the ultimate melting of the ice in th British Isles coincides with the Ragunda stadiu that De Geer's geochronology has dated 6800 B. The Irish Late Glacial peats and laminated clays, a interpreted by Jessen at Ballybetagh and Ralagha fit in very happily; and when the work begun b De Geer on the Dunning varved clays of Perthshi is carried further, the British side of the picture ma be expected to take clearer shape. (A Committee fo Quaternary Research in Ireland has been at wo since 1934: how long will it be before such a nationa committee is formed in Great Britain ?) For early Post-Glacial times the evidence is less intricate, but Dr. Movius's lucid exposition of the Litorina ("25-foot") raised beach is very welcome, and leads him naturally to the subject of the land-bridges and the human migration into Ireland from Britain. All this will be read by natural science workers with interest, and no doubt with appropriate criticism; but it is no less important for the prehistorian, in that the initial Irish Stone Age gives us no 'classic industries' which can be used as dating-fossils on a received typological basis, but itself requires dating—and by means that only a natural chronology can supply.

This Dr. Movius has seen to. On to the natural chronology summarized in his Table 6, his excavations have enabled the Irish Stone Age cultures to be projected. They are confined to the north-east, where alone flint for their tools abounded. The earliest station is the site near Tombe Bridge on Lough Neagh, sealed below Late Boreal–Early Atlantic peat, and material of the same initial culture is present in secondary position, preceding the maximum Litorina submergence of Atlantic times, in three coastal sites within varying distances of Larne, whence the cultures are to be known as 'Larnian'. To the Early Larnian succeeds the Late Larnian of the overlying deposits here and elsewhere along the coast; and after that the story continues into the 'Neolithic' Age which came in with the Sub-Boreal period towards 2000 B.C., and beyond the limits of this book.

Who and what were the Larnian people ? They were fishermen, hunters, and food-collectors, like their 'Obanian' counterparts of south-west Scotland, and the author's analytical and comparative study of their material culture shows them to have been descendants of the final Upper Palæolithic remnant who had crossed over from Great Britain well back in the Boreal period. Little touched (owing to the ensuing Litorina submergence) by external Mesolithic influence, they lived in a Mesolithic fashion of their own, developed in response to their secluded natural environment. Neolithic and later colonists pushed them in part into the interior, but they and their ancient food-gathering economy came to no abrupt end. In fact, they have demonstrably lived on as a basic stock among the Irish people to this day.

C. F. C. HAWKES.

SCABIES AND ITS TREATMENT

Scabies

By Dr. Kenneth Mellanby. (Oxford War Manuals.) Pp. xi+81. (London: Oxford University Press, 1943.) 5s. net.

SCABIES is at present a very important factor in both civil and military life. The itch is the commonest skin disease and, paradoxically, the one least recognized by the average medical man. War has been blamed for increases in the amount of scabies in Great Britain, but Dr. Mellanby doubts this and produces figures to show that there was already an increase in the scabies rate in the country between 1935 and 1939. He puts the present infestation rate at about 2 per cent of the population, rising to 5 per cent in some areas.

There is an excellent illustrated description of the life-history of *Sarcoptes scabiei* and instructions in the art of searching for the mite and extracting it for examination. Counts of live adult females on patients have revealed that the mean parasite-rate is astonishingly low, 11·3 per case, in spite of the widespread distribution of lesions. In only 3 per cent of cases were more than fifty parasites discovered.

It is confirmed that the chief mode of spread in adults is by close contact in warm conditions, so that a high percentage of cases come into the category of venereal infections. Bedding and fomites generally are not considered to be of real importance in spread, and Dr. Mellanby is of the opinion that dis-infestation of the clothing and bedding of cases after treatment is largely a waste of time, since any parasites therein are destroyed by the parasiticide used. This view has not yet found universal acceptance.

For treatment, sulphur ointment, Marcussen's ointment, mitigal and benzyl benzoate are ranked about equal for effective 24-hour treatment. The methods of treatment are described and the preparation of benzyl benzoate emulsions is included. Some illusions will be destroyed in the statement that scabies can be cured without the time-honoured baths and scrubbing, and in twenty-four hours at that.

This little book is the outcome of long and, as the reviewer knows, painstaking research on a large number of civil and service patients. The whole subject is completely covered and admirably condensed into an hour or two's easy reading.

VALVE TECHNIQUE IN SUBATOMIC RESEARCH

Electrical Counting

With Special Reference to Counting Alpha and Beta Particles. By Dr. W. B. Lewis. Pp. vii+144. (Cambridge: At the University Press, 1942.) 10s. 6d. net.

INVESTIGATIONS on radioactivity and cosmic radiation often require the detection of fast particles or the determination of their ionization. Ionization chambers and Geiger-Müller counters are used for these purposes; but the very small electric quantities obtained directly make high amplification desirable.

Research workers will welcome Dr. Lewis's book covering many aspects of valve technique in recording or observing fast particles. Among many other problems the book deals with the design of linear amplifiers suitable for the measurement of the ionization of α-particles. A survey is given of the various types of recorders suitable for high input-rates. A scale-of-ten circuit is described which has the advantage of being 'all electric', that is, it avoids the use of a mechanical recorder altogether. The Rossi coincidence circuit is described, and methods are discussed for obtaining high resolving power coincidence circuits.

The book deals only with material which was available before the outbreak of war. This is regrettable as the illuminating investigations on the discharge mechanism of Geiger-Müller counters carried out since are not dealt with.

In our experience the excessive precautions recommended for the use of Geiger-Müller counters (see p. 102) are rather exaggerated.

The presentation of the book is somewhat sketchy. Details might have been left out to make room for a more thorough discussion of some important points, such as the limits of resolving power of simple coincidence circuits or the properties of multivibrator circuits.

L. JÁNOSSY.

Magnetic Crack-Detection

Notes on Working Principles and Use of Apparatus. By G. B. Young. Pp. vii+60. (London: Charles Griffin and Co., Ltd., 1942.) 2*s*. 6*d*. net.

THE author states that this little book has been prepared at the request of friends in inspection departments to combine an outline of the working principles with the practical information needed in connexion with magnetic crack detection. In the light of this it is difficult to find justification for the historical notes which form the opening. On the other hand, the principles underlying this method of inspection might, with great advantage, have been more fully and more clearly stated. The majority of its readers will have a very slight knowledge of the fundamental principles of magnetism, and probably none of their bearing on exceptional cases as represented by flawed material. Terms such as flux, field distortion, magnetic susceptibility will be almost meaningless to many, as the average examiner of crankshafts, gear-wheels, ball-races, etc., is by no means likely to have qualifications in magnetism. The discussion of different types of flaws with little, if any, reference to their influences on the magnetization of the body in which they occur may be regarded as extraneous, as the reader is, or should be, presumed to know them all already, while the man who is unfamiliar with this branch of inspection will find the information inadequate.

Halfway through the book, the author begins to open up his subject proper by giving practical directions on the methods of operating the machines in magnetizing and testing bars, slabs, disks and flat surfaces. For the testing of rings, the Johnson-Fel ring jig is recommended, but, though it is thus indicated as an accessory to the actual process of examination, not a word of description is devoted to it. There certainly will be found many practical hints or tips which would be most useful to the examiner who has learned to use the machines, and has already been trained in the subject of crack detection. Considering, however, the many possibilities of cracks or flaws being overlooked in consequence of mishandling the machine, say, by exceeding, or failing to reach the correct magnetic strength, one is bound to say that a more comprehensive view of the needs of the uninitiated reader should have been adopted.

The Tropical Sky

Maps of the Constellations visible in the latitudes of the West Indies, Guianas, Nigeria, E. Africa, Ceylon, Malaya, etc. (5° to 10° N. or thereabouts), and of the Planets and Solar System, showing how and where to Identify Them in their Starry Background. Compiled by H. E. Watson. Pp. 27+3 maps. (Georgetown: *Daily Chronicle*, Ltd., 1942.) 3*s*. 6*d*. net.

THE title of this work is a sufficient explanation of its scope; the maps will prove helpful to beginners who wish to learn the positions of the constellations and their principal stars, which are given up to magnitude 5. Separate charts are provided for finding the planets, and directions are supplied for making use of these charts at different periods.

A number of explanations are given of various astronomical matters, but unfortunately many of these are either inadequate or misleading. Some examples are selected and perhaps these will be rectified in a later edition. P. 8: It is incorrect to say that the Star of Bethlehem was a comet. There is no proof for this supposition. On the same page it is stated that meteors "are pulled down on to the earth if they approach us too closely". Meteors encounter the earth irrespective of our planet's attraction, which has very little to do with the cause of the encounter. P. 9: It is stated that the Milky Way contains some 3,000 million stars. The actual number is probably about thirty times this figure. P. 11: It is doubtful if an object glass 1½–3 in. in diameter, complete with brass cell, can be purchased for 15–30*s*. If such a price were paid one might suspect that the resulting telescope would not be achromatic. P. 13: It is not correct to say that Galileo was tortured until he recanted.

On Map 1 the constellation of Telescopium is printed as "Telescopum". M. D.

Electrical Engineering Practice

A Practical Treatise for Electrical, Civil and Mechanical Engineers. By J. W. Meares and R. E. Neale. Fifth edition, revised and enlarged. In 3 vols. Vol. 2. Pp. xii+668+32 plates. (London: Chapman and Hall, Ltd., 1942.) 35*s*. net.

THE previous edition of this book appeared in 1927, and many changes in practice have taken place since that year, so that the new edition should prove welcome. The work is too well known to need detailed comment, and it is only necessary to remind readers that this particular volume is concerned with the transformation, conversion and storage of energy; distribution and control in branch circuits; and applications of electrical energy. These main divisions include transformers, rotary convertors, rectifiers, electronic devices, secondary cells, circuits and systems of supply, circuit accessories and wiring systems, and, on the applicational side, lighting, heating, cooking, cooling, air-conditioning, and welding and cutting.

The book has been revised completely and new material has been added where deemed necessary. The basic conception remains as originally planned, and the work is useful alike to the student and the general engineer. In its new form the book should enjoy all the popularity of its predecessors.

Electrical Technology for Telecommunications

By W. H. Date. Pp. iv+160. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1943.) 5*s*. net.

AS times change so the fundamental needs of particular types of students require re-orientation. The author has had considerable experience in training electrical students for varied branches of applied electricity, and the war-time pressure on educationists to emphasize telecommunications, especially radio, must lead them to reconsider what in fundamental theory their students must know in view of the known work they are later to undertake. Without anticipating more specialized telecommunication work, the author has found space, by rejecting the direct-current machine and the associated technology, for whole chapters on inductance, capacitance, and transformers, and their reaction to alternating currents. As a first introduction to the subject the author is clear and comprehensive, at every step indicating examples of magnitudes and usage; the more subtle aspects of the subject do not, of course, appear.

L. E. C. Hughes.

CALCIUM METABOLISM AND NUTRITION PROBLEMS*

By Dr. J. D. ROBERTSON
Courtauld Institute of Biochemistry,
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Normal Calcium Metabolism

THE skeleton is the sole calcium store in the body[1]. The calcium in the cortex of the bones is relatively stable, only being drawn upon in severe calcium deficiency; the calcium in the bony trabeculæ is, however, continuously taking part in the calcium exchanges of the body. In banking terms, the cortical bone calcium represents the deposit account, and that in the trabeculæ the current account.

The presence of this store must explain the remarkable constancy of the blood calcium in spite of fluctuations in the intake and output of calcium. There is practically no calcium in the blood cells, but the serum contains about 10 mgm. per 100 ml. (In sixty normal healthy men and women the average was 10·4 mgm. per 100 ml., all the values lying within the narrow range of 9·9–11·1 mgm. per cent.) The serum calcium is higher in children than in adults, but no variation has been detected in old age[2].

The chief exogenous sources of calcium in the food are milk, eggs and similar dairy products and green vegetables—though it should be remembered that the large amounts of calcium present in spinach are not absorbed owing to its high oxalic acid content[3]. It must also be borne in mind that the absorption of the ingested calcium from the gut is influenced by several factors. The presence of free hydrochloric acid in the stomach aids absorption by forming soluble calcium salts; good fat absorption also promotes calcium absorption. The ratio of calcium to phosphorus in the diet is important, particularly in infants, where the ideal Ca : P ratio is 2 : 1, as is found in maternal milk; with increasing age the maintenance of this ratio becomes less essential, though the phosphorus must not greatly exceed the calcium, for insoluble tertiary calcium phosphate may be precipitated in the bowel under such conditions. Vitamin D also aids absorption of calcium from the gut when it is given in doses of 700–1,000 I.U. daily (the anti-rachitic dose); larger amounts, however (50,000–1,000,000 units: the calcæmic dose), promote the mobilization of calcium from the skeleton and its subsequent excretion. Recent experimental work has also produced evidence that the presence of phytic acid[4] in the diet inhibits the absorption of the calcium, while the presence of protein[5] tends to promote it.

Calcium may also be derived endogenously from the skeletal reserve present in the body stores as described above.

Excretion of calcium from the body occurs both through the kidney and the gut; 25 per cent being lost in the urine and 75 per cent in the fæces. The fæcal calcium is composed of that part of the ingested calcium which is not absorbed as well as of calcium actually excreted into the bowel. Calcium is also lost from the body of the pregnant woman in building the fœtal skeleton and also secreted in large amounts in the milk during lactation.

The normal calcium metabolism of the body is influenced by the activity of the thyroid and parathyroid glands—chiefly by the latter. Experimentally, in both man and other animals, parathyroidectomy results in a fall in blood calcium which may be cured by the administration of parathyroid extracts[7]. The effect of the thyroid gland is not so well known, but thyroxine apparently influences the excretion of calcium by the kidney. In thyrotoxicosis the calcium output in the urine is increased, but on the other hand it is decreased in myxœdema. Subtotal thyroidectomy in the first case and thyroid administration in the second relieves the clinical conditions and under such treatment the urinary calcium output returns to normal[8].

Normal Calcium Intake

The optimal amounts of calcium that should be ingested daily to promote ideal health are believed by nutritional experts[9] to be the following: adults, not less than 800 mgm. daily; children, not less than 1,000 mgm. daily; pregnant and lactating women, about 2,000 mgm. daily.

These figures have been derived from studies on the calcium balances of normal healthy people. Individuals fed on a calcium-free diet still excrete calcium (when such a diet is fed indefinitely calcium is lost from the skeleton, and though the body makes an effort to conserve calcium by decreasing its excretion, calcium never becomes completely absent from urine and fæces). If calcium is added to this diet in gradually increasing amounts, the calcium lost will at first still exceed the intake, but eventually a level of calcium intake is reached where there is equilibrium—intake and output being equal. In normal people this equilibrium is reached with an intake of about 550 mgm. per day. Some individuals may show an equilibrium intake as low as 200 mgm. per day; this is evidence that they habitually take a calcium-deficient diet, since the body has adjusted itself by decreasing its normal output so far as it can, as happens in prolonged complete deficiency as described above. The optimal calcium intake is higher than this equilibrium figures, since it has been shown that such higher intakes benefit growth, weight, fitness, health and maternal efficiency in both animals[10] and man[11].

It is a noteworthy fact that an intake of 800 mgm. per day which is given above as the optimal intake for a normal adult also represents the minimum amount of calcium required to bring about maximum storage. That is to say, any intake in excess of 800 mgm. per day will be excreted unchanged in the fæces unless the individual is calcium deficient.

During pregnancy and lactation, of course, the calcium requirements of the body are much higher—generally about 2,000 mgm. per day. As two-thirds of the fœtal skeleton is formed during the last three months of pregnancy the increased intake should start during the fifth month of pregnancy, or earlier, and should be continued throughout the period of lactation to supply the calcium secreted in the milk. The pregnant and lactating woman loses as much calcium in the urine and fæces as she does normally[12], showing that there is no mechanism for conserving calcium in spite of the abnormal demands made on the body.

Calcium Deficiency

Clinical examination will only provide evidence of severe degrees of calcium deficiency; the chief signs are softening and bending of the bones (osteomalacia), brittleness of the bones, which become very liable to fracture, and tetany. In spite of this insensitivity in the estimate of calcium deficiency, osteomalacia and tetany have been reported in Great Britain, due to a low calcium intake[13].

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* Substance of lecture before the Royal Society of Arts, delivered on March 3.

Radiographic examination of the skeleton gives a somewhat more sensitive indication of calcium deficiency, but again the low degrees of deficiency are undetected, as is shown by the fact that in spite of the marked calcium loss in thyrotoxicosis only the most severe 25 per cent of cases show any decalcification of the trabeculæ in their radiograms[16]. Radiographic evidence of decalcification resulting from low calcium intake has been found in Great Britain[17].

A different method of approach is that of the mass dietary surveys that have been made in Great Britain and the United States[14]. Sir John Orr[14] finds that the lowest three of the six income groups into which he divides the population are getting insufficient calcium; these groups comprise a total population of twenty-two million people. It was found that the consumption of staple foods with a low calcium content such as bread and potatoes was almost the same throughout all six groups; the consumption of the foods with high calcium content (milk, cheese, eggs and green vegetables) increased, however, with increasing income. The higher income groups with the higher calcium intake showed lower incidence of disease, an increased rate of growth in the children, an increased adult stature and generally improved health and physique when compared with the lower income groups. That these benefits were not derived from the better housing conditions and decreased overcrowding is shown by the data of McGonigle and Kirby[15], who studied the health of a group of slum dwellers who were re-housed in a new estate in Stockton-on-Tees. Contrary to expectation, there was an increase in their sickness-rate. This was attributed to the fact that the increased rents led to a decrease in the money spent on food.

Another method of estimating the calcium saturation of the individual is that of the calcium balance determination. As described in an earlier paragraph, any individual who attains calcium equilibrium on a calcium intake of less than 550 mgm. per day, or if an intake of more than 800 mgm. per day results in a greater amount of storage than an intake of only 800 mgm. per day, may be considered to be calcium deficient. Such evidence for calcium deficiency in Britain also exists[17,18].

Calcium Intake in War-time Diets

Under war conditions the supply of the calcium-rich foods is limited: milk and cheese are rationed, eggs almost non-existent, green vegetables only available seasonally, and fish scarce. The priority class of children under five and pregnant and lactating women are allowed one pint of milk per day and a variable cheese ration which at present is 4 oz. per week. The calcium content of this ration is about 800 mgm. per day, which means that, with other sources, the total intake will be at least 1,000 mgm. per day. School children of 5–18 years of age get about $\frac{3}{4}$ pint of milk and their daily intake is probably 800–900 mgm. of calcium daily. The adults, with their daily milk ration of $\frac{2}{7}$ pint of milk, will have a daily calcium intake of about 500–600 mgm. In practice, the women and children probably do not eat all their cheese ration and the men probably forgo some of their milk. This may mean that the figures computed above are on the high side. If we eat all our rations our calcium consumption is only equal to that under pre-war conditions, and it has been shown above that there is ample evidence to show that our pre-war consumption was sub-optimal. Since it is impossible to increase the available amounts of the calcium-rich foods, calcium has been added to one of the staple calcium-poor foods—bread.

Addition of Calcium to Bread

This proposal has led to some controversy so that it is important to stress the following facts. The suggestion that a daily supplement of calcium to the diet would be beneficial is at least eighty years old[19] and actually led to improvement in health and physique. (See, for example, the recent experiment carried out in India showing that daily supplements of calcium lactate or milk had equally beneficial effects on a group of school children[20,21].) The practice of adding calcium to grain was established in Mexico and Peru when Columbus discovered America[22] and was employed with success by Germany in the War of 1914–18[23]. In Great Britain the amount of chalk added to 280 lb. of flour is 7 oz., while the daily intake of bread is about 14 oz. per day per person; which means that the average extra calcium consumed is less than 200 mgm. daily. There have been suggestions that this added calcium might have harmful effects. If this were so, such harmful effects of excess calcium should be observed in the hard-water districts of Britain, where the water contains 12 mgm. of calcium per 100 ml., so that 200 mgm. would be consumed for every three pints of water drunk. The million or so people who live in such districts, however, show no signs of ill-health. The districts are generally considered the most healthy in Great Britain, including most of the health resorts and watering places (for example, Weston-super-Mare, Bath, Ramsgate, Margate, Leamington Spa, Bournemouth and Folkestone among many others).

Summary

The normal processes of calcium metabolism and the factors influencing it are described.

Methods of determining the optimal calcium requirement and estimating degrees of calcium deficiency are reviewed, together with the evidence that such deficiency exists among large groups of the population.

Difficulties of increasing the calcium intake in war-time are pointed out.

It is calculated that the excess consumption of calcium due to the fortification of bread with chalk is no greater than that of people living in hard-water districts, which include most of the British health resorts and watering places.

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ANCIENT MONUMENTS OF CYRENAICA AND TRIPOLI*

By Prof. J. L. MYRES, O.B.E., F.B.A.

BETWEEN the western edge of the Nile Delta and the most eastern spurs of the Atlas ranges, before they pass over from Tunis into Sicily, North Africa consists of three distinct geographical regions, with distinct historical experiences. The 'Western Desert' from the Egyptian point of view, or 'Eastern Libya'—to distinguish it from what lies farther west still—is a low-lying slab of Tertiary limestone, marls and sands. It receives less Atlantic moisture, and greater summer heat, and has long been essentially desert; but ancient Egyptians knew it as a reservoir of pastoral tribes and of olive culture, and their general name *Tamahu* meant both 'Berber' and 'olive'. Its oases, Kharga, Siwa, and others, are still centres of population and intercourse, and as it extends westward inland of Cyrenaica, we should include, with those, the oases of Jerabub and Augila. Indeed, there is no natural frontier or change of regime, in the far interior, east of the Red Hamada plateau, of which the sea frontage is Tripolitania. This Eastern Libya has a dangerous and almost harbourless coast: Mersa Matruh is the only landing place, and a very poor one, between Alexandria and Bardia.

West of Sollum, the low interior plateau rises, and also extends to the sea, in the abrupt *Katabathmos* or 'Step-down' through which the only passage is *Halfiya* ('Hell-fire Pass'). It continues to rise, and to present a steep cliff frontage, nearly to Benghazi, and also forms a nearly semi-circular promontory seaward; while southward it subsides into the low desert hinterland. This block of Africa has in fact broken loose, and failed to subside with the regions east and west. But there are two distinct blocks, with escarpments one behind the other and a lower terrace between, all deeply dissected by ravines draining the wide plateau inland. Sometimes, and especially to westward, there is a coast plain seaward of the lower escarpment. As the plateau rises to 2,500 ft., Cyrenaica has enough winter rainfall for pasture in the interior, and retains patches of its old forests on the escarpments; and at the base of the upper escarpment deep springs break out, the most famous of which, sacred to a local deity, Cyra, gave its name to Cyrene, as Apollo's spring to Apollonia on the coast. Near Benghazi, underground water has caused the plateau to collapse into deep basins lined with rich moist soil, the 'gardens of the Hesperides' which gave Benghazi its earlier Greek name.

Greek settlement began in 631 B.C., at Cyrene, which became very prosperous, with corn, vines, and olives on the terrace and escarpments, sheep on the moors inland, and a monopoly of the *silphium* plant, an umbelliferous household remedy, gracefully advertised on its lovely coins. It attracted friendly natives, and Greek adventurers from all parts, and hived off other colonies along its seaboard, all recognizable, though none so impressive as Cyrene itself. Benghazi (renamed Berenice from an Egyptian patroness) had a notable sanctuary, and has yielded the only Greek statue of real merit. Barca's rich tombs were furnished with Attic vases of good period; Teucheira and Tolmeita (Ptolemais) have walls and Roman mausolea; Tolmeita had also a guild of gladiators, who adopted professional names: 'Hermes formerly Philo'. Apollonia, the port of Cyrene, was wrecked so utterly by earthquake that the site is a wilderness of columns and architraves, with the rock-cut road winding up the ravine, with deep wheel-ruts from its heavy traffic.

Cyrene itself stands above its spring, where two deep ravines isolate and defend its citadel, a bluff spur of the upper plateau, with the sacred spring in its eastern face. Here a natural shelf has been enlarged, and temples of Apollo, Artemis, and other deities have been built, with accommodation for pilgrims; for the sanctuary became famous, and the original shrine was twice rebuilt, with unusual architectural makeshifts. It has recently been cleared, and partly reconstructed. Round the head of the ravine which carries the road grew up the spacious city, with market-place and public buildings, other temples, and a racecourse and cisterns out on the plateau.

What makes Cyrene unique among Greek cities, however, is its amazing cemetery. The tabular limestone was easily excavated into chamber-tombs, with architectural façades and forecourt, in recognized styles, Doric, Ionic, and Egyptian, and many queer experiments. Of these tombs there are many hundreds, besides free-standing shrines like little temples, sculptured sarcophagi, and tower-like family mausolea. Probably, like the Temple of Apollo, these monuments were originally decorated with stucco and bright colour. Unfortunately, all that are exposed have been looted long ago: the only chance of discovery would be where debris from uphill has smothered some of the lower ranges of these chambers.

Fortunately, Cyrene lies a little aside from the main thoroughfare from east to west; and as it has not appeared in the news as a strong-point, it may be hoped that the monuments have not been damaged.

Tripoli, the third geographical region, is itself in three districts: (1) lowland almost waterlogged behind the Great Syrtis—the 'quicksands' of St. Paul's voyage—from El Agheila westward; (2) the Tarhuna moorland, behind Misurata and Homs; (3) another lowland, where the Tarhuna downs draw back from the coast into the higher and steeper frontage of Gharian, before returning coastward in the Matmata ridge and the Mareth position at its seaward end. Of the 'Three Cities' (*Tripolis*) which gave this region its ancient name, the most easterly, Leptis (now Homs), lies among the seaward spurs of Tarhuna; Sabrata (now Zlieten) and Œa (now Tripoli) are on the frontage of the coast plain, farther west. Tripoli alone has a defensible position and a permanent harbour, for a low ridge of tabular limestone protrudes beyond the long beaches, and bending eastward encloses a considerable port. Leptis in earlier times had been the chief centre, but its harbour was constructed in the mouth of a small stream, and this has silted and destroyed it: the coast also has risen some twenty feet since Roman times, and the quay wall, with lighthouse, boat-steps and bollards, is high-and-dry.

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* Summary of an address to the Royal Anthropological Institute delivered on March 23.

Unlike Cyrenaica, which came into Greek hands without trouble with the Libyan natives, Tripolitania was from the first a cause of quarrel between Greeks and Carthaginians, and the natives supported the latter. For long it was simply 'the depots' (*Emporia*); but after the fall of Carthage in 146 B.C. the Roman protectorate made it accessible, and it became a great source both of grain and of oil. Like Cyrenaica, too, it attracted many Jewish traders. At the end of the third century A.D., Leptis gave Rome one of its most efficient emperors, Septimius Severus, who did not forget his birthplace, and built a palace for his wife, and other impressive buildings. These, overlooking the harbour, became buried in sand dunes when disaster came, so rapidly and completely that after recent excavation they rival Pompeii and Algerian Timgad as an illustration of Roman culture in its later prime.

Neither Tripoli nor Zlieten have monuments to compare with those of Leptis; but the four-faced triumphal arch built for Marcus Aurelius in 164 A.D. in the civic centre of Œa is a fine monument of its kind; and at Zlieten the ground plan of the principal buildings can be traced, and has been partly excavated. The mosaics in private houses, though not so large or splendid as those of Sousse (Hadrumetum) in Tunisia, are among the best in North Africa.

When Tripoli fell to the Arabs, the conquerors were amazed that indemnities and tribute were paid in gold coin; but the citizens explained: "This is what people pay for our oil". How extensive this oil industry became is shown by hundreds of oil farms with stone-built presses, all along the Tarhuna highland. When first visited by travellers, they were described as 'megalithic'—and indeed their stones are very large; but they are based on Roman concrete, on sites with Roman masonry and potsherds, so there is no doubt of their date; the whole process of milling and pressing the olives is depicted on Roman reliefs and frescoes; and the same type of lever press has been seen at work by a modern traveller in Morocco. After the present turmoil, one may hope for re-establishment of this characteristically Mediterranean industry in what seems to have been one of its earliest and most productive homes.

SCIENCE AND THE CITIZEN: THE PUBLIC UNDERSTANDING OF SCIENCE

THE Division for the Social and International Relations of Science of the British Association held a conference at the Royal Institution in London during March 20–21 to consider ways and means for increasing the public understanding and appreciation of science. For more than a hundred years the British Association through its annual conferences has endeavoured to introduce science to the citizen, but the fact remains that to-day, in the midst of a scientific age, science and the citizen are still very insufficiently acquainted. As was so frequently stressed during the course of the conference, we are living in an era in which the discoveries of science are becoming an essential constituent of our everyday life, and an understanding of the spirit and service of science is of the utmost importance for the people and its leaders if our civilization is to survive.

The Exposition of Science

Sir Richard Gregory, president of the Association, in opening the conference, said that since the beginning of history there has always been a lag between stages of scientific knowledge and social and moral wisdom. He considers that what is particularly needed to-day is the promotion of public interest in the close relationships of natural science with other humanistic studies which influence the thoughts and actions of all citizens.

A message from Sir John Anderson, Lord President of the Council, emphasized the vital contributions which science will have to make to the solution of post-war problems. It pointed out that much harm may be done if those without scientific training are encouraged by extravagant advocacy of the marvels of science to expect from science alone remedies for all the social problems which will have to be faced.

A message from Prof. Joffe, vice-president of the Academy of Sciences of the U.S.S.R. (see below), was received but unfortunately not in time to be read to the meeting, and another from Dr. Harlow Shapley and Mr. Watson Davis of Science Service, suggesting immediate international co-operation in the distribution and popularization of scientific information.

Sir Henry Dale, who presided, reminded the audience of some points in the history and associations of the Royal Institution, which was formed with aims closely resembling those to be considered by the conference. He said that the public understanding of science needs for its achievements the co-operation of the two parties concerned—the men of science and the people. The former must study all the means available for interpreting and expounding their problems and achievements, and the whole people must be prepared to receive the message. If Great Britain is to play its part in the civilization now in the making and to keep step in the march of progress with the other great world communities, nothing will suffice short of a recasting of our schemes of education. Science must be given its proper and central place at every stage in elementary, secondary, university and adult education.

Sir Lawrence Bragg dealt with the difficulties of getting the scientific message to the public. Scientific workers are often accused of being too technical in their presentation of their subject. There is some truth in this, but the real trouble is that science has not been regarded as an essential part of a balanced education. We have a number of fine industrial laboratories in Great Britain, but the industrial leaders more often owe their positions to their commercial and financial ability than to their technical ability.' In industry, scientific men are too often regarded rather as experts to be called in when there are troubles, not as colleagues to be called in when making plans. He advocated greater personal contact between scientific consultants and members of the Government, rather than the appointment of advisory committees.

Sir Lawrence gave some useful advice as to how to give a popular scientific lecture, his own talk being an admirable illustration of the points he mentioned.

Prof. Allan Ferguson gave an account of the great expositors of science in the eighteenth and nineteenth centuries with particular reference to Faraday and Huxley, whose passionate love of truth and clarity of expression are eternal examples for future generations to emulate.

Dr. Arnold Raestad, former Minister of Foreign Affairs to the Norwegian Government and now governor of the Norwegian Bank, spoke about the international dissemination of science. He formerly presided over the committee of scientific men appointed in 1938 by the League of Nations (through the International Institute of Intellectual Co-operation in Paris) to consider the means of improving, by organizational measures, the way in which the results and methods of science may be presented to a general public. All modern media of current presentation were considered—lectures, press, films, exhibitions and radio. The committee recommended the creation of an international centre for scientific information. The War has interrupted these efforts, but war-time experience has only emphasized the urgent necessity of such work, and it is to be hoped that as soon as conditions permit the committee will renew its attempt to bring a knowledge of international scientific progress within the reach of every citizen.

Mr. J. A. Lauwerys spoke about museums and the interpretation of science. He considers that the national museums of Great Britain are second to none in the world, and two hundred others are good. But the remaining six hundred are junk shops in which curators, generally very poorly paid, collect salvage. They bear very obviously the marks of the social system which has given them birth. Even among the good museums, science is but poorly represented. There is not a single planetarium in the whole country, though many German and American cities possess good ones.

In this matter, we have much to learn from the United States. There, a great many museums are attempting to present ideas to the public, instead of merely housing and preserving collections. Their methods of display, based upon the fundamental laws of effective display, are often superb. They use the resources of modern engineering and craftsmanship, and they have learned much from the art of the modern window-dresser. Materials are presented so as to show their functions; exhibits are presented in progressive stages of development; the displays are integrated and the relationship between what is shown and contemporary civilization is plain.

Mr. Lauwerys advocates a Museum of Science as one of the most important buildings of a great civic centre in each of our cities after the War.

Radio and Cinema

Sir Allan Powell, chairman of the Board of Governors of the B.B.C., took the chair at the second session, when radio and the cinema were discussed. He commented on the great progress which has been made in radio technique since the War.

Mr. G. Ivan Smith, who has produced many talks on science in Australia and in the B.B.C.'s Empire Service, considered the difficulties with which a producer of science talks has to contend. He thinks that science must be introduced to the untrained listener by an emotional appeal. The listener must be made to 'sense' the close relation of science to his own personality by programmes on the chemistry of the body, the soil, plants, or the applied physics which create his material environment. Then the scientific worker must be induced to take infinite pains to interpret himself to his fellow citizens in language that can at once arrest their attention and be easily intelligible.

Sir Robert Watson-Watt sees the greatest obstacle to bringing science to the citizen in the lack of a common language. In using the radio as a medium for the explanation of scientific facts, it is most desirable that the personality of the speaker should be projected into the home audience. For this, high-quality transmission is a first consideration.

According to Dr. C. D. Darlington, science, as we now have it, is nothing less than the arrangement of knowledge for the benefit of mankind. For a hundred years science has been transforming the world, and for a hundred years government has been painfully stumbling behind. More than ninety per cent of the people who govern us are ignorant of the method and meaning of science. They have been educated in a pre-scientific age by an educational system which instead of integrating the future with the past has bent all its efforts to their separation.

After commenting on the strange oversight which excludes from the Board of Governors of the B.B.C. a representative of the profession which brought the radio into being, Dr. Darlington said that the first step is to establish a science committee to prepare, co-ordinate, and direct a science policy in broadcasting. This committee would have to think out how to raise the scientific interest and understanding of the public. It would address itself to the educable fraction of listeners, which Dr. Darlington thinks might be increased from 5 to 25 per cent. Programmes would be included to cover industry, housing, agriculture, food, medicine, health, education and social habits, biography and topical science news.

There should be plenty of time for such broadcasts. The 'Home' programme at present includes 7 hours of religious broadcasting a week and 20 minutes of scientific. The 'Forces' programme includes 1¼ hours of religion and no science at all. Whatever the obstacle to scientific broadcasting may be, it is certainly not time.

Dr. D. McClean, speaking as a representative of the Association of Scientific Workers, outlined a scheme for the general orientation of the B.B.C. programmes in order to convey the scientific attitude without dulling the appetite of the ordinary listener. He advocates the adoption of a general scientific outlook or method of approach in all discussions, social, economic, educational and informative, and also an increase in the specifically science programmes. He suggested that there should be a scientific worker as a regular commentator on passing events, and a permanent committee of representatives of the scientific profession to advise on and to develop ideas for the B.B.C. programmes.

Miss Mary Field discussed the principles of making a biological film, and the role of the biological film in education. She stressed the point that the biological film, as so many people tend to forget, is only a piece of educational equipment in the hands of the teacher. It cannot teach by itself or take the place of slow, painstaking personal observation and work. But for introductory or revision work, for showing movement of all kinds and for studying the behaviour of specimens, at all times of the year or over a period of years, it is invaluable—nor can biology be taught so well without it.

Mr. Paul Rotha sees a great future for scientific films in educating our political leaders, industrialists, Civil servants and others in whose hands lie the power to make use of science, and who are scientifically illiterate or obstinately anti-scientific. Films will also be needed for specialists in many fields who need to know how science affects their work, for example, farmers. A lead in scientific film-making has been given by the Ministry of Information, and certain industrial firms. The film industry itself must be induced to produce films about science.

Science as a Humanity

Speaking from the chair on the history of humanism, Prof. J. L. Myres maintained that: (1) from the beginnings of a humanistic outlook, in antiquity, and also at the revival of learning (in the fourteenth century), the natural sciences had undisputed and indispensable place among the humanities; and (2) that they lost that place when the technological demands of modern industrialism claimed for them a status apart from the 'more humane studies', in the hope of producing experts and specialists in some one line of lucrative research at the age of twenty-two or so. He decried the overburdening of modern timetables, which left zoologists no time to read the "Origin of Species".

Prof. B. Farrington gave a brilliant interpretation of the first two hundred years of Greek science (600–400 B.C.), when for the first time in history the idea of a scientific attitude to external Nature, to man and to society was conceived. Modern historians have conspired to describe their achievements as a miracle, a tribute no doubt to the brilliance of their ideas, but a sad comment on the success of their endeavour, which was to banish miracle from Nature. The originality of the Ionian method of explaining Nature was that it sought to interpret all Nature in terms of the familiar processes by which man himself exercises control over limited portions of Nature's domain. The things going on in heaven and under the earth were the same sort of things as were going on in the kitchen, in the workshop, in battle and on the farm. This way of explaining Nature belongs to a period when techniques were held in high honour in society and form an integral element in the culture of the dominant class. Ionian science changed its character, tending to become exclusively logical and mathematical when the growth of the institution of slavery freed the citizen from manual work and separated him from most forms of practical operational control of nature.

Mr. F. R. G. Duckworth, chief inspector of secondary schools for the Board of Education, thinks that the scientific approach and the artistic approach must be taught concurrently for the full understanding and appreciation of natural phenomena.

Dr. R. V. Southwell devoted his address to a consideration of the 'average man', to whom the exposition of science by the radio, cinema and press will in the future be addressed. The cultural value of science is in its development of a special kind of thinking, and it is some acquaintance with this 'scientific thought' which is wanted in the education of normal citizens, rather than the teaching of factual knowledge about science. It should be the aim of education to develop also other kinds of thought which are necessary for a fully developed personality: the thinking needed for an appreciation of the arts, the thinking trained by a study of languages, the thinking which reveals itself as wisdom in the affairs of life itself. It is in a truly balanced education of this kind that science should play its part.

Prof. W. E. Le Gros Clark considered the place of the biological sciences in the humanities, and how in general education they may be treated in particular relation to their bearing on human problems—the problems of the individual and collective living. Thus, the concept of organic evolution is of vital importance in emphasizing the unity of man with the organic world. The principles of heredity, dealt with by reference to laboratory experiments on insects and plants, can be applied to heredity as it affects man in the control of hereditary disease and the improvement of animal stock. Plant physiology can be related to agricultural problems and food production, animal physiology to human physiology. With the introduction of biological sciences into the general educational curriculum, biological problems which intimately affect human society will be more rapidly and satisfactorily solved, since the social conscience will have been awakened and inertia based on public ignorance will no longer be possible.

An account of the growth of discussion groups in the Army under the direction of the Army Bureau of Current Affairs was given in a paper by Mr. W. E. Williams, director of the Army Bureau of Current Affairs, read by Dr. O. J. R. Howarth. A.B.C.A. is an improvised experiment in mass education. The discussions, which are compulsory, and take place in working hours, cover a wide field of interest. The most popular topics are those which affect the individual. 'What does it mean to me?' is the approach which most quickly rouses attention and eloquence. The most frequent deficiency in the discussions is accurate knowledge, and the effects of cutting off education at the age of fourteen are often lamentably evident. As a war-time innovation, A.B.C.A. has already made a profound effect on the Army, and it is to be hoped that something of this experiment will survive the War and be incorporated into civil life in peace-time.

Dr. C. H. Waddington, whose paper was presented by Dr. D. P. Riley, envisages science not so much as one of the humanities but rather as potentially providing a point of view which can succeed that of the humanities as the ideological focus of the new society which is coming into existence. If science can formulate a view of man which, by emphasizing his essentially social nature, is profounder than that of the individualistic capitalist era, it will have played a by no means negligible part in bringing the new society to birth.

Science and the Press

At the final session, the chair was taken by Sir Richard Gregory, who dealt with some prominent characteristics of the scientific movement following the publication of the works of Mill and Darwin. These works had a great influence in releasing thought and inquiry from conventionalism and in revealing relationships between the nature of man and his environment. The foundation of Nature towards the latter part of the last century was a landmark in promoting this movement.

Mr. Ritchie Calder, formerly science editor of the *Daily Herald*, was optimistic about the effect of the War on the mental attitude of the average reader, the average journalist and the average scientific man. The newspapers have been purged, scientific men have been drawn from their isolated position into public life and the average reader, through national service, has been given a new way of life and a new outlook. In a war of scientific weapons, they have become to a greater or lesser degree scientific. This new population will demand new treatment from the Press. He thinks that there will be a need for a British Institute of Scientific Information linked with similar organizations throughout the world, which will maintain a regular supply of scientific information for dissemination in the various countries. A similar idea was put forward by Mr. Henry Martin, of the Press Association.

Mr. J. G. Crowther put forward many suggestions for increasing the popular understanding of science, pointing out that there is no simple way of bringing this about. The improvement of science reporting in the Press depends on the simultaneous advance of several interests: the increasing interest and demand from the public; the effects of a higher standard of science teaching; the raising of the school-leaving age; the recognition by owners and editors of newspapers of the growing importance of science; recognition by the State and philanthropic bodies of the necessity for better public understanding of science; the efforts of scientific men themselves to make their activities better known and understood, and the promotion of scientific interest which arises from the increasing mechanization of daily life. He advocates a full-time science editor for every newspaper, and a science news service providing reliable science news to all newspapers which subscribe to it.

The work which the Association of Scientific Workers is doing in publicizing science was described by Dr. D. S. Evans. The Association already has groups of people actively engaged in publicizing science in a large number of its branches, and steps have been taken to train members in the technique of popular science writing. Their aims are to counteract the perverted ideas of science in the Press as instanced by astrology pages and pseudo-scientific advertisements; to show the people what can be done by science during the period of reconstruction after the War and to protect the people from wrong systems of government offered in the light of arguments which appear to have a scientific background.

The Press was further criticized by Prof. J. B. S. Haldane, who said that more space is devoted to anti-science than to science. One of the first things to effect is a revision of the laws of libel so that some action could be taken against the lies perpetrated in patent medicine and other advertisements. He advocated a science news service; science features in every newspaper; a science reporter for every newspaper, and scientific and technical advisers attached to the staff of every newspaper to direct policy.

Mr. Francis Williams considered how the Press, instead of giving occasional publicity to sensational science news, could become a vehicle for the consistent interpretation to the public of the social impact of scientific development upon the world. He considered the possibility of producing a paper independent of advertisement revenue.

It was at this final session on science and the Press that Mr. H. G. Wells sounded the death knell of newspapers as we know them to-day. The time has gone, he thinks, when we shall have to buy four daily newspapers in order to find out what is being concealed from us. He visualizes a time not far off when we shall dial NEWS as we now dial TIM, and receive the latest bulletin over the wires. There are promising signs that the public are demanding informative matter to read and will no longer tolerate newspapers which give no news and exist for the commodities advertised in them. Bound books will disappear. Ideas will be ventilated in paper-covered books and pamphlets, sold at a price within the reach of all, and these will do what the newspapers have failed to do. Finally, old, stale, out-of-date textbooks must be burnt. The best-sellers of the future will be scientific books bringing to the citizen an awareness of the age in which he lives.

B. M. H. Tripp.

Message from Prof. Joffe, Vice-President of the Academy of Sciences of the U.S.S.R.

I deeply regret being unable to avail myself of the kind invitation from the president of the British Association and from the British Council, conveyed to me by the British Ambassador, Sir Archibald Kerr. The reason preventing me from travelling to London is excellently expressed in the very subject of this Conference: "Science and the Citizen", which does not admit of my leaving my post and my work just now. . . .

The great pathos of the war for the freedom of my country and of all mankind has aroused in all of us a feeling of responsibility to our people. We know that science is no longer a plaything in our hands but a mighty weapon which, in these stern times, must serve the cause of defending humanity, ensuring mankind a happier future; and these are the tasks of science in days of peace also. The destinies of mankind are not determined by wars alone, as the Nazis preach; they are moulded by centuries of creative toil. In peace and in war-time our object is one—the happiness of our peoples, a happy life for all mankind. Science has already accomplished much towards this; people hear each other and will soon see much of each other across the seas and oceans; in cinemas they are witnesses of the great battles of Stalingrad and Moscow and in Libya; within a few hours they are conveyed from one end of the country to the other; they build ships in one month; they raise fruit and vegetables in the winter; they overcome pneumonia and contagious diseases. But at the same time we scientific men know better than anyone else what vast opportunities still lie dormant, how long is the path from scientific discovery to its ultimate realization.

What is needed is to shorten this process so that every citizen himself feels the full benefit of science and research.

We have long ago in the U.S.S.R. set ourselves this task. Our people, our Government have demanded its solution of us. With this aim in view we carefully thought out plans for our work, concentrating our forces on the most vital problems and seeking the most effective means to introduce into practical life what we had mastered. We do everything possible so that our knowledge speedily becomes the domain of engineers, physicians and agronomists who can give it practical application; the domain of the workers who effect those physical and chemical processes which we investigate. Finally, it is necessary that this knowledge forms part of the foundation of general education in the schools and among the general population.

We organize joint work between scientific men and engineers. Even without planning, science brings benefit, but its role vastly increases when this aim is consciously striven for.

Allow me to disperse some regrettable misunderstandings. The introduction of planned principles in science by no means signifies rejection of fundamental theoretical researches which give no immediate practical results. On the contrary, a proper plan demands that, side by side with the utilization of science for current tasks, it also lays the foundation for the future. History teaches, and our experience proves outright, that major practical results are achieved when succeeding in revealing the mechanism of natural phenomena, when attaining the broadest possible generalizations.

Theory and practice mutually support each other. There is no better checking of theory and analyses of its shortcomings than the experience of mass production. Allow me to cite an instance of my own experience: solely by means of developing quantum theory semi-conductors we have succeeded in raising dozens of times over the current given by new rectifiers, photo-elements and thermo-elements. On the other hand, many features of this theory were prompted by failures in factory production.

Another misunderstanding which has not yet been fully dispersed is the conviction that the sole aim for scientific creation should be the striving for knowledge and not its benefit for mankind. When you learn that so and so many ships with thousands of sailors have been saved, that so and so many air-raids threatening our native towns have been averted, that so and so many tanks have been saved owing to your work; if you are given grounds to think that the scientific activity of yourself and your comrades in the Academy of Sciences helps to avert the menace threatening to enslave your people—does not this multiply our strength and promote the success of our research?

We scientific men enjoy the privilege of combining two supremely gratifying features; in striving for knowledge we thereby increase the happiness of our people and win its recognition. Both these aspects stimulate the development of science and make the man of science a worthy citizen.

Modern science is proceeding by the united efforts of many scientific men who all tackle one problem from various angles. Individual attempts seldom yield important results. Therefore, a man of learning who is isolated from life is not only a bad citizen but also a poor man of science.

I feel that I am not telling you anything new, the reason I am telling you these truisms is that for us they are the result of the experience of twenty-five years on which our science has grown up and which is so highly appreciated by our people. From the first day of war we men of science joined the peoples' ranks and took our stand in the defence of our country. From us scientific men, each soldier and sailor expects help, and we don't disappoint them. As they at the front, we in the laboratory dedicate day and night to our single cause. This is the cause of all scientific men, all citizens who love their freedom and respect the freedom of other nations. Stimulated by patriotic feelings, science constitutes a prepotent force; and this force is in our hands. . . .

Before us stretch bright perspectives of progress and free development of all peoples along the roads they themselves may choose. Before us stretch the boundless perspectives of scientific creative endeavour. Let us then unite our efforts quicker to disperse this menace so that the free citizen can breathe deep again. Time does not wait, the sufferings of millions grow.

OBITUARIES

His Eminence Cardinal Hinsley

ARTHUR, CARDINAL HINSLEY, whose death occurred on March 17, was born in 1865 in Yorkshire. He was thus seventy years of age when, on St. George's Day 1935, he took possession of the Metropolitan See of Westminster, to which he had been appointed by Pope Pius XI. In the seven years which followed, he became a great national figure, whose influence extended far beyond the limits of his own flock, and whose clear, uncompromising leadership in his country's crisis was recognized as a great national asset. His voice at the microphone conveyed a message which awakened an immediate response in the heart of the British peoples in every part of the Empire—he could express high thoughts that were struggling for utterance in the nation's soul, in forthright words and manner that the nation recognized as its own.

Such an achievement, in so short a time, and at such an advanced age, was the outcome of immense self-forgetting energy, and should greatly hearten those whose advancing years lead them too easily to give in to feelings of inadequacy. Those who had business with the Cardinal were often amazed at the detailed attention he gave to his correspondence and at the number of letters he wrote with his own hand, at a time when his health was giving constant cause for anxiety. These manuscript letters will long be cherished by those who have them—the writer of this notice has a number of them before him as he writes, each with its words of kindness, of insight and genuine interest, and of encouragement. The Cardinal's personality seems to 'come through' in his letters just as it did in his voice heard on the radio.

Even before his appointment to the See of Westminster, His Eminence had earned a title to the gratitude of his countrymen for the work he had done in the field of education. After graduating at the University of London, he obtained a doctorate at the Gregorian University in Rome and gained the diploma in philosophy of the Academy of St. Thomas. Thereafter his practical interest in education never flagged during the whole of his long life. In 1928 he was appointed Apostolic Visitor to the African Missions in British Territory, and for six arduous years carried out the delicate and responsible task of securing the co-operation of missionary educational agencies with the advances in native education being urged at that time by the Colonial Office. His success in this work, and the satisfaction he gave both to ecclesiastical and government circles, were such that in 1930 he was appointed Apostolic Delegate in Africa and his powers consequently extended to missions in certain non-British territories.

During his years at Westminster, the Cardinal maintained the liveliest interest in questions affecting African education, and was instrumental in inaugurating a special colonial course for intending missionaries to fit them for the educational and administrative responsibilities they would be called upon to assume. The main part of this course was given in the Institute of Education of the University of London, and it was supplemented by series of special lectures on cultural anthropology, comparative religion, native psychology, etc.

The Cardinal gave every encouragement to professional men and women of his own flock to play their part fully in the scientific life of the country—especially in furthering the applications of the social sciences to the material, mental and spiritual well-being of mankind. He was quick to recognize good wherever he saw it, and favoured the closest possible co-operation, consistent with firm principles, with the various agencies working in the social field outside his own communion.

WE regret to announce the following deaths:

Major Leonard Darwin, president during 1911–28 of the Eugenics Society, on March 26, aged ninety-three.

Mr. E. Harrison, registrary of the University of Cambridge, and fellow and formerly senior tutor of Trinity College, on March 28, aged sixty-five.

Mr. E. Heron-Allen, F.R.S., known for his work on the Foraminifera, on March 28, aged eighty-one.

Mr. A. Holm, C.M.G., C.B.E., formerly director of agriculture, Kenya, aged sixty-four.

Mr. R. W. Paul, founder of the well-known instrument-making company known by his name, which was eventually amalgamated with the Cambridge Instrument Co., Ltd., on March 28, aged seventy-three.

Prof. C. F. Tolman, professor emeritus of economic geology of Stanford University, on October 13, aged sixty-nine years.

Mr. W. Trevor Watson, K.C., who specialized in patent law and scientific cases, on March 24, aged fifty-six.

NEWS and VIEWS

Avebury

But for the War, the acquisition by the National Trust of Avebury, and also of Windmill Hill, would certainly have created a more considerable stir. This Bronze Age monument is one of the most impressive of its kind in Europe; and the lesser site at Windmill Hill has given its name to one of the main neolithic pottery groups of the British Isles. Doubtless the Avebury stone circle owed its importance to its geographical position, situated as it was at the meeting place of a number of ancient downland roads. In its prime, after its last reconstruction, it must have formed a magnificent ensemble with its great circular ditch and rampart and approaching avenue of tall standing stones. Great Britain owes a great deal to Mr. Keiller, who has been excavating Avebury at his own expense for many years past. The lack of interest in former days, and the propinquity of a village, had resulted in the partial destruction of a great deal of the monument and the breaking up of many of the stones for building purposes. Mr. Keiller acquired the property and set to work to examine the site scientifically, and, where possible, to re-erect the fallen stones. The result has been the saving of a unique possession. Windmill Hill, too, is of extreme scientific interest. Earlier in date than the Avebury we see to-day, its excavation has yielded precious data for the elucidation of British culture at a remote period. It is satisfactory to feel that the monuments and Mr. Keiller's work on them will now be preserved for all time for the nation.

Engineering Economics

THIS was the title of a paper presented on March 25 before a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers by Sir Frank Gill, who explained that his purpose was to urge the leading institutions to include the subject of engineering economics in the qualifications required for admission to corporate membership. Although an essential part of the equipment of a practising engineer in fitting him to decide or advise upon the most economically sound detail or scheme to adopt, this is a branch of training which has, in the main, received little attention. He described 'engineering economics'—distinct from the university meaning of economics—as being related to the question "Which of several plans, schemes or designs, each technically sound for the same job, is it advantageous to select?" Engineering plans and decisions must be technically sound; they must also be financially advantageous, and to stress this view several examples were mentioned. In deciding upon the size of a telephone exchange, for example, the advantages increase up to a certain number of subscribers but beyond this they diminish, and it was for a training in the methods by which such economic analyses should be made that Sir Frank pleaded.

Unfortunately, the discussion was mainly wide of the mark, and most of the speakers criticized mere details such as the limited nature of the examples cited, which had no real bearing on the point at issue. Although not helpful, the remarks made by the several speakers carried the implication that the training advocated by Sir Frank is necessary. How advantageous, then, would have been a discussion on the method by which the training might be given, at what stage and the means by which the obvious difficulties might be overcome in the schools. Prof. R. O. Kapp, Pender professor of electrical engineering at University College, London, alone gave some suggestions from his experience in trying to fill the gap, and one came away feeling that, with good will, teachers in the universities and colleges could very easily give a lead in inculcating the principles and technique by introducing an economic as well as a technical objective in the problems and designs which are set for the training of their students.

Centenary of the Royal Dockyard Schools

At Portsmouth on March 28 the Royal Dockyard School celebrated its centenary when Mr. A. V. Alexander, First Lord of the Admiralty, distributed the prizes. In his speech to the apprentices Mr. Alexander said that "from the dockyard schools have come many leaders in naval construction and engineering and some had been elected Fellows of the Royal Society. In founding the schools and making attendance compulsory the Admiralty anticipated by twenty-seven years the adoption of compulsory education by the State and anticipated day continuation schools by scores of years." The list of eminent naval constructors, shipbuilders and marine engineers who began their scientific training in the dockyards is indeed a long and distinguished one and the country owes a debt to the pioneering work done by the Admiralty in technical education. There had been a School of Naval Architecture at Portsmouth from 1811 until 1832, but that had been closed in a foolish fit of economy by Sir James Graham, the First Lord. It had left its influence, however, and by 1841 another scheme was afoot for training apprentices. This led finally to an Order in Council of February 1, 1843, for approving the establishment of schools in the dockyards, each of which had had a committee preparing plans. In 1843 Chatham, Portsmouth and Pembroke Schools were opened, and the schools at Sheerness, Devonport, Deptford and Woolwich were opened between 1844 and 1848. A notable event in the history of the schools was the appointment in 1846 of the Rev. Henry (afterwards Canon) Moseley as the inspector of schools, and it was largely due to his experience, criticism and proposals that the schools were placed on a really sound footing. At the present time no fewer than eleven ex-Portsmouth dockyard apprentices are studying at the Royal Naval College, Greenwich, which was opened in 1873 on the closing of the famous Royal School of Naval Architecture and Marine Engineering at South Kensington.

Continuation of Education Interrupted by War Service

The Government has announced that steps are being taken, as at the end of the War of 1914–18, to provide suitably qualified men and women with the means to continue, on demobilization, education or training which has been interrupted by war service, with the object of replenishing the supply of those qualified to fill responsible posts in the professions, industry, including agriculture, and commerce. The scheme will apply to all those whose further education has been interfered with by service in the Armed Forces, civil defence bodies, or by undertaking work of national importance. It is intended to cover training in business concerns as well as courses at universities, technical colleges and training colleges. It is also proposed to take steps to provide facilities for those who will be retained by Service Departments during the period of resettlement before demobilization is complete. An interdepartmental committee, including representatives of the universities, is being appointed to ensure that training and educational arrangements are related to prospects of employment at home and abroad. An independent committee will advise the Minister of Labour and National Service, acting through the Appointments Branch of the Ministry, on methods of securing co-operation with professional, industrial and business organizations and with education authorities, in order to assist trained men and women to obtain posts after the War. Lord Hankey will be chairman of both these committees. Inquiries regarding these schemes should be addressed to the Secretary, Board of Education, Belgrave Square, London, S.W.1 (by those normally resident in England or Wales), or to the Secretary, Scottish Education Department, St. Andrew's House, Edinburgh, 1 (by those normally resident in Scotland).

Summer School in Biology and Health

The re-organized Central Council for Health Education, which enjoys the support of the Ministry of Health and the Board of Education, together with the most important health and educational associations, is arranging a Summer School in Biology and Health to be held at the Chelsea Polytechnic, London, during August 4–14. The first three days will deal with "The Biological Basis of Education", and various sessions will trace the life of a child from conception to adolescence. The lectures will cover heredity, early childhood, stages of physiological and psychological development, and questions of individual and social health. This course should be of value not only to all teachers and educational administrators, but also to youth leaders, play-centre and nursery-school workers, health visitors and school nurses, and, indeed, all who have to do with children and young people. The succeeding week will deal with "Biology in the School", and is designed specially for teachers of biology and others interested in that subject. While the mornings will be devoted to 'text-book' biology, and the afternoons to experimental demonstrations and visits, the evening lectures will relate biology to its social setting.

The Council has been fortunate in securing the services of several eminent men of science and educationists. Prof. C. W. Valentine, professor of education in the University of Bristol, will speak on "Early Childhood", and Prof. Winifred E. Cullis on "Sex Education". A matter of great topical importance, "The Social Aspects of Nutrition", will be dealt with by Prof. J. R. Marrack, professor of chemical pathology in the London Hospital Medical College, and if his other engagements permit, Prof. Lancelot Hogben, professor of zoology in the University of Birmingham, will speak on "Biology as a Social Science". It is hoped that other authorities well known for their views on biology as an educational discipline will address the school. The lighter side so essential to the success of a Summer School has not been neglected. Visits will be arranged to the Science Museum, Kew Gardens, and Rothamsted Experimental Station; socials and dances will be held at the Polytechnic, and time will be left free for other individual arrangements. The Summer School fee will be 5½ guineas for the full ten days, and 2½ guineas for the first three days only. These figures include not only tuition, but also lunch, tea, and dinner each day. Since many students will prefer to stay with friends in London, the fee is not calculated to include sleeping accommodation and breakfast, but the organizers of the school will be glad to help other students to make such arrangements. The school will be jointly directed by Mr. L. J. F. Brimble, chairman of the Central Council's Educational Advisory Committee, and Dr. F. J. Harlow, principal of Chelsea Polytechnic. The Summer School Secretary is Mr. Cyril Bibby, Education Officer, Central Council for Health Education, Tavistock House, London, W.C.1, to whom enquiries should be directed.

Vacation School on Social Biology

A vacation school on "Social Biology in Relation to Human Life and Culture" is to be held under the auspices of the British Social Hygiene Council, beginning on July 30 at Eton College. The school will last for a fortnight; the cost will be £6 6*s*. a week inclusive. The programme will consist of morning instructional courses on social biology, its place in education and its bearing on current social problems. For these, Prof. A. E. Heath, professor of philosophy in University College, Swansea, Dr. Marjory Gibbons, Mrs. E. J. Hatfield, Prof. L. P. W. Renouf, professor of zoology in University College, Cork, Mr. R. Weatherall (of Eton College) and others are making themselves responsible. Still wider aspects of social biology will be dealt with in evening lectures and conferences, in which Prof. F. A. E. Crew, Mr. W. L. Sumner, and Father Leycester King are hoping to participate. In the first week the courses will be planned to appeal mainly to teachers of all kinds, not only to science teachers. In the second week they will relate to problems which concern not only educationists but also welfare workers, magistrates, labour managers and all others confronted with present-day social and administrative problems. Further information can be obtained from the British Social Hygiene Council, Tavistock House South, Tavistock Square, London, W.C.1.

The Ray Society

At the general meeting of the Ray Society held on March 25, it was agreed that, under suspension of the laws of the Society, the officers and Council at present serving be re-elected for the current year. In the annual report of the Council it was stated that the affairs of the Society continue in a satisfactory condition. Prof. Tattersall's monograph on the "British Mysidacea" is approaching completion and a considerable number of the illustrations are in the hands of the engravers. Proposals for the publication of several other works are under consideration by the Council, but under present conditions considerable delay in publication is unavoidable.

Science and the War Effort in the United States

A paper on "The Fuller Utilisation of Scientific Resources for Total War" presented by Dr. T. Rosebury at a meeting of the New York Branch of the American Association of Scientific Workers on October 7, which has now appeared in *Science* (96, 571; December 25, 1942), shows a similar concern over the failure to utilize scientific resources to that which exists in Great Britain, and also that the American Association of Scientific Workers is actively concerned with this problem. The broad outlines do not of course differ in the two countries, and with much that is being done in the United States readers of Nature are already familiar. The chief feature of interest in Dr. Rosebury's paper is its account of the encouragement and organization of individual volunteer scientific activity by the Office of Scientific Research and Development. Emphasizing that leadership however competent is not enough, Dr. Rosebury points out that any responsible scientific worker can formulate a war project and submit it as an application for a contract to the O.S.R.D. or to one of its sub-committees. If the application is approved, a contract is granted, and funds for assisting personnel and for equipment and supplies are made available for the work; Dr. Rosebury describes the way in which the services of a group of bacteriologists in New York were utilized in this way. Finally, he indicates the way in which scientific workers can assist on the home front, and deal with the problems that will result from shortages of trained personnel and assist in securing the full utilization of scientific facilities, equipment and materials, where the National Registry of Rare Chemicals, maintained under the auspices of the Armour Foundation, and the National Research Council have already pointed the way. Dr. Rosebury, however, suggests that ultimately all scientific activity should be centralized and co-ordinated by a single government agency.

Sterilization of Sulphanilamide Powder

The report of a fatal case of tetanus due possibly to infection from the container of a sulphonamide powder applied locally emphasizes the desirability of the practice, already adopted in the United States, by which all sulphonamide preparations intended for topical application are marketed ready sterilized in sterilized containers. At a conference recently held between representatives of the Medical Research Council and of the Association of British Chemical Manufacturers, it was agreed that the Hynson, Westcott and Dunning procedure is suitable for adoption also by British manufacturers of sulphanilamide powder, and that the powder thus sterilized should be issued in sterile packets each containing 5 gm. Since this recommendation must inevitably take some time to put into full effect and would not apply to existing stocks of the powder held at hospitals and first-aid posts, suitable methods for small-scale sterilization were also considered and various procedures recommended. It is thought that sulphanilamide powder for local application should not cake or be more than slightly discoloured by any of the proposed techniques.

Announcements

The Association of University Professors and Lecturers of the Allied Countries in Great Britain has arranged a conference, to be held at the Royal Institution on April 10. The morning session, beginning at 10 a.m., will deal with "The Function of a University in a Modern Community"; the afternoon session, beginning at 2.30 p.m., with "Methods of Practical Co-operation between Allied Universities in the Future". Tickets can be obtained from the Conference Secretary, Association of University Professors, 40 Queen's Gate, S.W.7.

The Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at agricultural colleges or university departments of agriculture, for diploma or degree courses in an agricultural subject or at veterinary colleges for courses in veterinary science; and six extended junior scholarships (for those who have already held junior awards), and thirty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding a year in duration, in agriculture, horticulture, or dairying. Information concerning the scheme and forms of application may be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W.1, or from the offices of County Councils. The latest date for submitting applications is April 30.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Reactions of Hæmoglobin and its Derivatives with Phenyl Hydroxylamine and Nitrosobenzene

ON addition of a small amount of phenyl hydroxylamine ($C_6H_5.NHOH$) to a fresh alkaline solution of hæmatin prepared from hæmin crystals, the colour of the solution turns rapidly from brown to bright red and its absorption band at about 630 mμ is replaced by two strong but somewhat diffuse bands at 562 mμ and 532 mμ. Two molecules of phenyl hydroxylamine per molecule of hæmatin are required for the complete formation of this new compound. Its instantaneous formation suggests in the first instance the view that in this reaction hæmatin combines directly with the phenyl hydroxylamine in the same way that it does with a variety of other nitrogenous substances. This view was not, however, supported by further experiments, which can be summarized as follows:

(1) The new compound is formed much more slowly in complete absence of oxygen. Thus, if hæmatin solution is put in a Thunberg vacuum tube, the phenyl hydroxylamine in its hollow stopper and the contents of the tube are mixed only after the complete removal of air, the new compound appears very gradually.

(2) Although the presence of oxygen greatly accelerates the formation of this compound, it is, when formed, more stable in the absence of oxygen. In air it gradually decomposes, liberating the hæmatin, and this decomposition is accelerated by shaking the solution with air.

(3) Addition of sodium hyposulphite to the new compound decomposes it, liberating the unbound hæm ($Fe^{\cdot\cdot}$).

(4) Addition of potassium ferricyanide also decomposes this compound, liberating the unbound hæmatin ($Fe^{\cdot\cdot\cdot}$).

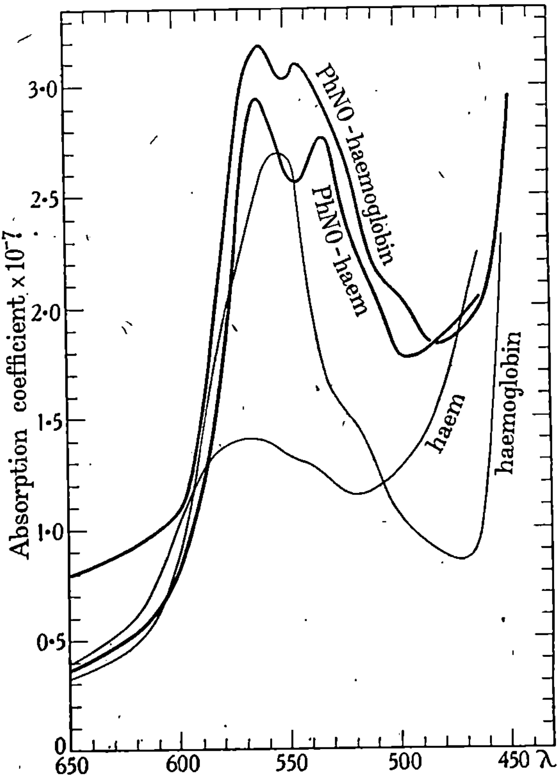
(5) In presence of carbon monoxide the new compound turns gradually into CO-hæm.

(6) A compound with similar properties is obtained by treating different parahæmatin compounds, such as pyridine parahæmatin, with phenyl hydroxylamine.

Somewhat similar results are obtained on addition of phenyl hydroxylamine to solutions of oxyhæmoglobin or methæmoglobin. In the case of oxyhæmoglobin, the reaction begins with the appearance of acid methæmoglobin. The latter, however, undergoes a marked change; its colour turns from brown to purple and its characteristic absorption spectrum is replaced by two bands at 560 and 543 mμ.

As in the case of hæmatin, this new compound is much more rapidly formed in the presence of oxygen. In the absence of oxygen, phenyl hydroxylamine reduces methæmoglobin to hæmoglobin, and this reduction is followed by gradual appearance of the new compound. This new compound is not stable. Exposed to air, it reverts gradually to free methæmoglobin and this reaction is accelerated by shaking the solution. On treating it with potassium ferricyanide it turns immediately to methæmoglobin; in presence of carbon monoxide it forms carbon monoxide – hæmoglobin, while on treatment with sodium hyposulphite it forms reduced hæmoglobin, which on shaking with air oxygenates to oxyhæmoglobin.

The above experiments show that phenyl hydroxylamine reacts both with hæmatin and with methæmoglobin, forming two very similar but not identical compounds. The facts that in presence of carbon monoxide and without addition of a reducer these two compounds give carbon monoxide – hæm and carbon monoxide – hæmoglobin respectively, clearly indicate that the iron in these two new compounds is in the ferrous state. The first step in this reaction is therefore the reduction by phenyl hydroxylamine of hæmatin and methæmoglobin to hæm and hæmoglobin respectively. This is, moreover, supported by the fact that these compounds are rapidly decomposed by potassium ferricyanide, liberating hæmatin and methæmoglobin. On the other hand, the facts that hæm and hæmoglobin in absence of oxygen react very slowly with phenyl hydroxylamine and that both new compounds are rapidly destroyed by sodium hyposulphite, liberating hæm and hæmoglobin, indicate that in these compounds, hæm and hæmoglobin are combined not with phenyl hydroxylamine but with one of its derivatives. Of several derivatives of phenyl hydroxylamine tested, such as aniline, hydrazobenzene, azobenzene, azoxybenzene nitrobenzene and nitrosobenzene, only nitrosobenzene (PhNO) was found to give, with hæm and with desoxygenated hæmoglobin, compounds absolutely identical with those which phenyl hydroxylamine gives with hæmatin and methæmoglobin respectively.



LIGHT ABSORPTION CURVES MEASURED WITH THE HILGER NUTTING SPECTROPHOTOMETER. ABSORPTION COEFFICIENT $= \frac{1}{cd} \ln \frac{I_0}{I}$ WHERE c IS HÆMATIN CONCENTRATION EXPRESSED AS GM. MOLS/C.C.

The reaction of phenyl hydroxylamine with hæmatin and methæmoglobin can, therefore, be explained as follows: phenyl hydroxylamine reduces hæmatin and methæmoglobin to hæm and hæmoglobin respectively, undergoing at the same time oxidation to nitrosobenzene. The latter then combines with hæm and hæmoglobin, forming the two new compounds (see accompanying graph). These results confirm a recent observation by Jung[1], who found that reduced hæmoglobin forms a well-defined purple compound with nitrosobenzene. Neither catalase nor cytochrome *c* react with phenyl hydroxylamine or nitrosobenzene.

The reactions described in this communication have some bearing on observations by Warburg, Kubowitz and Christian[2], as to the effect of phenyl hydroxylamine on red blood corpuscles of rabbits. On treating these corpuscles with phenyl hydroxylamine they have obtained brown methæmoglobin corpuscles; the oxygen uptake of which in presence of glucose was about twenty times higher than that of the untreated corpuscles. They also found that methæmoglobin of these brown cells, while it catalyses the oxidation of glucose, does not turn into oxyhæmoglobin as one would expect if this catalysis is accompanied by valency changes of iron.

They believe that methæmoglobin acts here as a real catalyst undergoing reduction to hæmoglobin, which instead of becoming oxygenated becomes reoxidized to methæmoglobin. According to these workers, such behaviour of methæmoglobin, although chemically unexplained, is of great importance for the theory of respiration.

The reactions between hæmatin compound and phenyl hydroxylamine described above suggest, however, that the peculiar behaviour of methæmoglobin within the red blood corpuscles described by Warburg *et al.* is not due to any special unexpected property of methæmoglobin itself but to the presence within these corpuscles of some derivatives of phenyl hydroxylamine. Of these derivatives nitrosobenzene combines with hæmoglobin every time it is formed by the reduction of methæmoglobin and protects it from oxygenation but not from oxidation to methæmoglobin. In fact, as we have just shown, nitrosobenzene-hæmoglobin exposed to air undergoes oxidation to methæmoglobin rather than oxygenation.

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E. F. HARTREE.

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[1] Jung, F., *Naturwiss.*, **28**, 264 (1940).

[2] Warburg, O., Kubowitz, T., and Christian, W., *Biochem. Z.*, **242**, 170 (1931).

Asymmetric Transformations

SINCE our work on asymmetric transformation is suspended owing to the existing emergency, we desire to make a statement of the present position and the essential steps leading up to it.

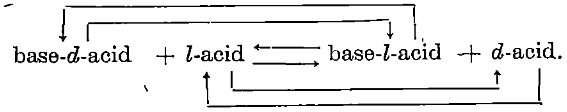
Read and McMath[1] observed that acetone solutions of *l*-hydroxyhydrindamine chlorobromomethanesulphonate exhibited marked mutarotation, and concluded that equilibration between *l*-base-*d*-acid and *l*-base-*l*-acid was responsible. They assumed that the active base exerted an 'asymmetric influence' on the optically unstable acid molecules. Mills and Elliott[2] in 1928 found that the brucine salt of N-benzenesulphonyl-8-nitro-1-naphthylglycine underwent what they termed "partial activation" in chloroform (acid : base ratio = 0·845 : 1), and attributed this to the "difference between the velocity coefficients of partial racemisation of the undissociated salts", although they also said that the observed mutarotation "must have been due to the establishment of an equilibrium in which an excess of brucine-*d*-acid salt was present". They made no quantitative measurements, but made a qualitative observation that the equilibrium rotation was changed by increasing the acid to base ratio, and concluded that "this may indicate a slight dissociation of the salt in chloroform".

In the case of diastereoisomerides in which one centre of asymmetry is labile and capable of being influenced by the other centre, the term 'partial racemization' has no physical meaning. Since the interconvertible salts, base-*d*-acid and base-*l*-acid, in which the acid is the optically labile component, will have different free energies in non-dissociating solutions, the amounts of the two salts at equilibrium will be unequal. In the equilibrium:

$$\text{base-}d\text{-acid} \underset{k_l}{\overset{k_d}{\rightleftharpoons}} \text{base-}l\text{-acid},$$

K, the equilibrium constant, is equal to k_d/k_l, and the measured rate constants for the approach to equilibrium from base-*d*-acid, base-*l*-acid and base-*dl*-acid must all be equal, being the sum of k_d and k . This simple conception was first put forward and experimentally established by us[3] in 1938. Further, knowing the specific rotations of either base-*d*-acid or base-*l*-acid, of base-*dl*-acid, and of the equilibrium mixture, together with $k_d + k_l$, we were able to calculate the individual values of k_d and k_l. We had previously obtained irresistible evidence[4] that in the systems we were investigating any dissociation effect must be extremely small. The term 'partial racemization' as applied to such a pair of diastereoisomerides should be abandoned in favour of the more accurate term 'equilibration'. 'Optical activation' is still a useful term for describing that part of the common equilibration process which is observable when base-*dl*-acid is the starting material.

Addition of excess of *dl*-acid upsets the equilibrium, but so far there is not enough evidence to enable a decision to be made as to whether this is due to disproportionation of the salts, of the free acids, or of both. The initial disproportionation may either be enhanced in the same optical sense, or reversed, by the addition of excess of *dl*-acid. As an example of the reversal effect, it was found in one case (Jamison and Turner[5]) that the 1 : 1 acid-base mixture contained more of the *d*- than of the *l*-acid (combined), and that the 3 : 1 acid-base mixture contained more *l*- than *d*-acid (free plus combined). As a result of this reversal effect, there is a certain ratio of *dl*-acid to base *at which no mutarotation occurs.* Combination of acid and base to give salt is extremely rapid (Jamison and Turner[6]) and therefore the only processes which need be taken into account in considering the equilibrium are representable (Jamison and Turner[7]) as below:



$$\text{base-}d\text{-acid} + l\text{-acid} \rightleftharpoons \text{base-}l\text{-acid} + d\text{-acid}.$$

At the point of no mutarotation, the concentrations of the various components must be those actually put into the mixture, that is, the concentrations of base-*d*-acid and base-*l*-acid are equal to one another, as are those of *d*-acid and *l*-acid, and any subsequent changes are mutually compensating. The concentrations of the components are known only at this point and at that at which there is no excess of *dl*-acid present. Attractive as the problem is, there is as yet insufficient evidence for its complete solution.

Exchanges and inversions of these types must involve transition complexes such as

d-acid ——— base ...... *l*-acid,

in which the base may be able to exert an asymmetric influence on more than one molecule of acid. That this influence has to be more intimate than a purely environmental one would appear to be probable from some preliminary (unpublished) experimental results obtained by us in 1941, concerning the rates of mutarotation of the brucine salt of *l*-2-chloro-N-benzoyl-6′-methyldiphenylamine-2′-carboxylic acid, in solution in *d*-, *l*- and *dl*-*sec*.-octyl alcohols. These rates, as measured, were experimentally indistinguishable, and although much more detailed work remains to be done, we are of the opinion that there has to be a fairly close association between the 'influence' and the labile substance for the latter to be affected. A similar conclusion follows from the many cases we have studied in which salt activation occurs in a non-dissociating and not appreciably in a dissociating solvent.

The mechanism of "second order" asymmetric transformation has been understood for a considerable time (see, for example, Leuchs and Wutke[8]), but until the appearance of our recent memoir[9] it had not been realized that if second order transformation, with separation of one pure diastereoisomeride, can occur in a non-dissociating solvent, then it must be preceded, that is, in solution, by a first order asymmetric transformation, optically antagonistic to the second order change, although the *measurable* effect of the first order change will in some cases be very small.

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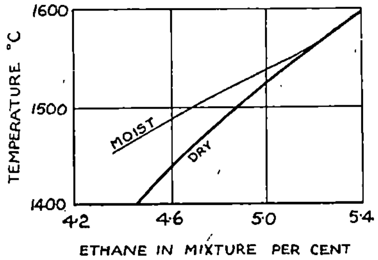
March 16.

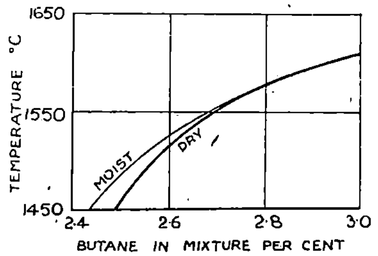
[1] *J. Chem. Soc.*, **127**, 1572 (1925).
[2] *J. Chem. Soc.*, 1291 (1928).
[3] *J. Chem. Soc.*, 1646 (1938).
[4] *J. Chem. Soc.*, 1650 (1938).
[5] *J. Chem. Soc.*, 266 (1940).
[6] *J. Chem. Soc.*, 1650 (1938).
[7] *J. Chem. Soc.*, 270, 272 (1940).
[8] *Ber.*, **46**, 2420 (1913).
[9] *J. Chem. Soc.*, 437 (1942).

Influence of Water Vapour upon the Combustion of Hydrocarbon Mixtures

It has been reported previously that flame gases resulting from the combustion of moist carbon monoxide – air and moist hydrogen – air mixtures attain higher temperatures than those resulting from the combustion of dry mixtures[1,2]. The temperatures were measured by means of very thin quartz-covered platinum-rhodium wires of overall diameter 0·0005 in. immersed in the flame gases just above the inner cone. The mixtures which were fed to the burner were on the weak side of the theoretical mixtures, and for any given combustible gas content the temperatures of the moist mixture flame gases were of the order of 50° C. higher than those of the dry mixture flame gases.

Similar experiments have been carried out with moist and dry mixtures of air and butane, propane, ethane (which contained approximately 10 per cent of ethylene) and ethylene. The results of the experiments with ethane mixtures (which showed the largest differences) and with butane mixtures (which showed the smallest differences) are summarized in the accompanying graphs. It will be seen that in the case of the weakest mixtures used the moist ethane mixtures yielded temperatures some 70° C. higher than the dry mixtures, whereas the moist butane mixtures yielded temperatures only about 25° C. higher than the dry mixtures. It will also be seen that as the mixture strength was increased the differences between the moist and dry mixture temperatures became less and less, until mixture strengths were reached in which the proportion of the combustible gas was about 90 per cent of the theoretical proportion, when the moist and dry temperatures were sensibly the same. Similar results were obtained with the propane and ethylene mixtures.





Reference to our previous letter relating to moist and dry hydrogen – air mixtures[2] will show that in the case of the flame gases from these mixtures the differences in the quartz-covered wire temperatures also tended to become less as the mixture strength was increased. Thus, for mixtures containing 21 per cent hydrogen, the moist mixture temperature was about 50° C. higher than the dry mixture temperature, but for mixtures containing 24 per cent hydrogen it was rather less than 40° C. higher. Further experiment has shown that with still stronger mixtures the difference between the moist and dry mixture temperatures steadily decreases; for mixtures containing 26 per cent hydrogen the difference was only about 20° C.

It should perhaps be added that a burner of special design was employed in these experiments, and that the combustible gas – air mixtures fed to it were previously carefully mixed in a large tank.

W. T. DAVID.
J. MANN.

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University, Leeds.
March 10.

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[1] David and Pugh, NATURE, **140**, 1098 (1937).
[2] David and Mann, NATURE, **150**, 521 (1942).

Formation of Porphyrin by Autolysing Yeast and by Yeast Press Juice

PRIOR to the outbreak of war, I was investigating the synthesis of porphyrins by yeasts, hoping to discover some clue as to the nature of the chemical reactions whereby hæmoglobin is elaborated by the animal organism. The main research had necessarily to be postponed, but I venture to think that certain observations made at the time may be worth recording.

It was found that some, but not all, yeasts, when allowed to autolyse at 48° in the presence of 1 per cent of toluene, showed an increase in coproporphyrin. That the precursor of this porphyrin was neither hæmatin, protoporphyrin nor uroporphyrin was demonstrated by the failure of additions of such materials to increase still further the 'extra' coproporphyrin found during autolysis. The same results were obtained when using zymin in place of fresh yeast, although quantitatively the increase on autolysis was smaller. Stale yeast (twelve days old) formed no extra coproporphyrin on autolysis, suggesting that possibly the amount of precursor or essential raw material for the synthesis is limited. This was borne out by the observation that even with a fresh yeast there is little further porphyrin production after the first thirty-six hours of autolysis.

A concentrate was then prepared from a fresh bakers' yeast, shown to about double its porphyrin content during autolysis, by boiling for ten minutes in water at *p*H 4·7, filtering and evaporating to the consistency of thick syrup. When such a concentrate was added to an active autolysing yeast, a large extra increase of coproporphyrin occurred.

Yeast press juice was then employed in place of autolysing yeast cells, and all the main results outlined above were reproduced, namely, some specimens of press juice did, and others did not, produce extra coproporphyrin, when incubated alone at 48° in presence of toluene. Addition of the yeast concentrate led in all cases, however, to considerable fresh porphyrin production. No significant increase occurred as the result of addition of either hæmatin, protoporphyrin or uroporphyrin. The table summarizes the results of the investigation.

Production of porphyrin by autolysing yeast and yeast preparations. All experiments carried out at 48° in presence of 1% of toluene. Coproporphyrin determined by acetic acid-ether extraction and comparison of absorption in acid solution with that of standard coproporphyrin.

Type of yeast or yeast preparation	Conditions of experiment	Duration	Result
'Stag' brewery yeast, 12 days old....	Autolysis in water	6 hr.	No increase in porphyrin
		3 days	,, ,, ,, ,,
Dried yeast (Lister Institute) no longer capable of fermenting	Autolysis in water	115 hr.	No increase in porphyrin.
	Autoclaved ¼ hr. at 10 lb. prior to autolysis	36 hr.	,, ,, ,, ,,
,, ,, ,, ,,	Autolysis with added concentrate	72 hr.	,, ,, ,, ,,
Distillery yeast, poor in cytochrome, 1 week old	Autolysis in water	6 hr.	Doubtful increase in coproporphyrin
As above, but fresh	Plasmolysed by NaCl, then autolysed	72 hr.	Approx. 75% increase in coproporphyrin
As above, rich in cytochrome, fresh	,, ,, ,, ,,	72 hr.	Approx. 70% increase in coproporphyrin
Zymin, active in fermentation	Autolysis in water	36 hr.	47% increase in porphyrin
,, ,, ,, ,, ...	,, ,, ...	115 hr.	53% ,, ,, ,,
,, ,, ,, ,, ...	,, + 1·4 mgm. Hæmatin	84 hr.	Possible "slight" (23%) extra coproporphyrin production
,, ,, ,, ,, ...	,, + 0·36 mgm. Protoporphyrin	,,	± Increase (12%) in coproporphyrin production. Only 35 μ gm. protoporphyrin recovered
Baker's yeast, fresh	Autolysis in water	24 hr.	Approx. 100% increase in coproporphyrin
Concentrate prepared from above	Incubation in water soln.	60 hr.	No increase in porphyrin
Press juice from fresh brewery yeast	Incubation alone	36 hr.	Approx. 100% increase in coproporphyrin
,, ,, ,, ,, ...	,, + 0·54 mgm. Hæmatin	,,	No extra increase in coproporphyrin
,, ,, ,, ,, ...	,, + 0·36 mgm. Protoporphyrin	,,	Slight ,, ,, ,, ,, ,,
,, ,, ,, ,, ...	,, + 1·46 mgm. Uroporphyrin	,,	No ,, ,, ,, ,, ,,
,, ,, ,, ,, ...	,, + 0·25 mgm. Coproporphyrin	,,	Complete recovery
,, ,, ,, ,, ...	,, + concentrate (≡ 50 gm. yeast)	,,	700% increase in coproporphyrin
Bakers' yeast	Autolysis in water	60 hr.	No increase in coproporphyrin
Concentrate prepared from above	Incubated alone	,,	No significant increase in coproporphyrin (control 14 μ gm., test 20 μ gm.)
,, ,, ,, ,, ...	,, + concentrate (≡ 100 gm. yeast)	,,	500% increase in coproporphyrin

The nature of the thermostable porphyrin precursor or raw material for porphyrin synthesis in the concentrate was not determined. The chemical reactions involved can apparently take place in a cell-free medium, which renders control much easier from a quantitative point of view, and by choosing suitable yeast for pressing, followed by a fractionation technique, the production of a stable active material which can be stored and used as required seems not impossible. Given these conditions, examination of the enzymic or chemical system responsible should aid materially our knowledge of the chemistry of pigment production.

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March 15.

Polygenes and Oligogenes

In a recent communication[1], I suggested that we can consider embryonic development in terms of two types of process; on one hand, processes which 'switch' the developing tissues into some one of a number of alternative paths, and on the other hand, the 'buffering' processes by which those paths are defined. Mather[2] afterwards attempted to develop this idea by identifying the genes which act in a buffering manner with his so-called 'polygenes' and the genes acting by switch mechanisms with 'oligogenes'—a new word which he coined to include the genes with comparatively large effects normally studied in genetic laboratories. I wish to show that this identification cannot be sustained and has only been suggested by extremely confused thinking.

In the first place, the concept of alternative paths of development has been applied to (in fact arose from) early embryonic changes, such as the determination of neural tissue at gastrulation. The genes which affect the differentiation of the neural plate into the neural tube would be acting as buffers in my sense, and they could not possibly be thought of as falling within Mather's definition of polygenes, since their effects on the adult would be profound and striking. Thus genes with large effects may nevertheless act in a buffering manner. Again, genes with small individual effects may act together to constitute a switch. This seems to be the case with the sex differential genes in many forms. Another example is provided by the genes *dachsous, four-jointed* and *combgap* in Drosophila; each has only a very small effect on the eye, but when all are present they combine to switch development of the eye-disk into a path of development which produced an antenna.[3]

Similar examples could be multiplied. What remains true in Mather's thesis is the obvious fact that genes which produce very minor changes in a character must be acting as rather ineffectual buffering agents on the last phases of its development. Such genes have been a commonplace of genetic thought since they were first considered by Nilsson-Ehrle in 1908. They have usually been known as 'multiple genes' or 'polymeric genes', but such phrases, like Mather's more recent name 'polygenes', actually imply a fallacy—the fallacy, namely, of making a one-one correlation between the gene and one of its effects. It is the same fallacy as is involved in speaking of the 'white eye' gene in Drosophila, when it is well known that the same gene also affects the colour of the testis-sheath, the fertility, the life-span, and other characters. Such a method of speaking is so convenient that its dangers can usually be accepted with advantage. Mather, however, seems to have fallen into the trap of thinking that polygenes, defined from "the polygenic nature of the variation which they determine", are genes of a special nature, which can be contrasted with other genes of a different nature, the so-called 'oligogenes'. Actually, one and the same gene can be a 'polygene' in respect of one of its effects and an 'oligogene' in respect of another; for example, to go no further than the example given above, the white gene in Drosophila would be a polygene if we were interested in its effects on life-span or fertility, an oligogene if we studied eye-colour. There is a true distinction between polygenic variation (determined by numerous genes) and oligogenic variation (determined by few genes); but this is certainly not a distinction between the kinds of genes involved, and need not correspond to a distinction between the modes of action of the genes during development. There may also be a valid classification of genes into 'active' and inactive ones (corresponding to the active and inert sections of the chromosome). This distinction is still almost entirely a theoretical one, relating, as it does, to the primary gene activities which remain obscure. But even if the possibility of such a distinction is accepted, it is clearly incorrect, as is shown by the example of "white eye colour" mentioned above, to identify the inactive genes with those determining polygenic variation.

With these considerations in mind, it might seem advisable, while retaining the useful adjective 'polygenic', to dispense with the substantive 'polygene', or at least always to use it with suitable qualifications; for example, in a phrase such as "the gene A acts as a polygene with respect to the character X".

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[1] Waddington, C. H., Nature, **150**, 563 (1942); see also "Organisers and Genes" (Cambridge, 1940).

[2] Mather, K., Nature, **151**, 68 (1943).

[3] Waddington, C. H., *J. Gen.* (in the Press).

Laboratory Synthesis of Diamond

The letter by Mr. Bannister and Mrs. Lonsdale in Nature of March 20, p. 334, records very interesting results. Whether Hannay did in fact succeed in producing diamonds must in the last resort be decided by the success or otherwise with which his experiments can be repeated. I have reason to believe that he presented a further paper on this subject to the Royal Society about 1894, which was not published by them, but the archives are not accessible at the moment and it is impossible to carry the question further.

Coming to the experiments of Sir Charles Parsons, I wish to put it on record that at the end of his life he did not believe that the hard crystals he had obtained at an earlier time were really diamonds: the reason being that they would not burn in oxygen. I make this statement on the strength of repeated conversations with him on the subject.

Terling Place, Chelmsford. Rayleigh.

Exotic Woodlice in the British Isles

I have recently received from a greenhouse near York a small (2 mm. long) white woodlouse, which I identify as *Trichorina thermophila* (Dollfus)[1], a Central American species. This, or an allied species, has previously been reported from glasshouses at Kew, Newcastle-on-Tyne, Winlaton Mill[2], Glasgow[3] and Belfast[4]. Kraepelin[5] reports the occurrence of this species at Hamburg, which had been imported with orchids from Nicaragua.

Among other species introduced into Great Britain are *Trichoniscus linearis* (Kew Gardens), *Nagara nana* (Belfast), *N. cristata* (Wylam-on-Tyne), *Angara lenta* (Chester), and *Cubaris* sp. (from Mombasa, British East Africa), one dead specimen, with bulbs.

In connexion with studies on the dispersal of woodlice, I should be glad to learn of other occurrences.

141 Fulford Road, York. Walter E. Collinge.

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[1] *Feuil. Jeun. Nat.*, 90–94, Figs. 1, 2 (1896).

[2] *Derwent Trans.*, 1–22, 14 figs. (1913).

[3] *Derwent Trans.*, 9 (1913).

[4] *Irish Nat.*, **20**, 155 (1911).

[5] *Mitt. Naturhist. Mus. Hamburg*, **18**, 204 (1901).

INFLUENCE OF A PROLONGED PARTIAL DEFICIENCY OF VITAMIN C ON THE RECOVERY OF GUINEA PIGS FROM INJURY TO BONES AND MUSCLES

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ISRAEL and Fränkel[1] and Schilowzew[2] have claimed that a deficiency of vitamin C in guinea pigs causes reopening of healed fractures, but Roegholt[3] and Hertz[4] could not confirm this finding. The former authors used diets which were probably deficient in vitamin D as well as in vitamin C, whereas Roegholt and Hertz supplied vitamin D. In view of these conflicting results we have studied the effect of a combined deficiency. Preliminary results had shown no indication of reopening of the callus on diets poor in vitamin C but containing ample vitamin D. In the present study we fractured the fibulæ of guinea pigs of about 300 gm. weight while they were on diets containing 1 mgm. of ascorbic acid daily, an amount of the vitamin which maintains normal growth in animals of this weight. Fourteen days later when, as shown by preliminary experiments, the callus had been formed, the animals were transferred to diets partially deficient in vitamin C. To investigate the influence of vitamin D, two groups of guinea pigs were given a diet almost devoid of vitamin D, as described below. We may say at once that no reopening of healed fractures could be observed, but we found other results which we wish to report shortly in this communication.

Experimental. Forty young guinea pigs were divided into four groups the diets of which were briefly as follows:

Group 1 (seven guinea pigs): *positive control, complete basal diet* (oatmeal, bran, dried yeast, and salt mixture) with daily 6 drops of 'Radiostoleum' (vitamins A and D) and 10 mgm. of ascorbic acid.

Group 2 (twelve guinea pigs): *almost totally deficient in vitamin D* (diet as Group 1, but instead of 'Radiostoleum', 8 gm. of carrots were given weekly).

Group 3 (four guinea pigs): *partially deficient in vitamin C* (diet as Group 1, but with only 0·5–1·0 mgm. of ascorbic acid daily).

Group 4 (sixteen guinea pigs): *partially deficient in vitamin C and almost devoid of vitamin D* (diet as Group 3, but with carrots instead of 'Radiostoleum'). Animals of this group received daily in their carrots almost 0·03 mgm. more vitamin C than was received by Group 3, a difference which could scarcely be significant.

Animals of Groups 2 and 4 went on to the vitamin D-deficient diet on day 1 of the experiment; the deficiency was then continued until the end of the experiment. Animals in Groups 3 and 4 received 1 mgm. of ascorbic acid daily from days 1 to 26, and then 0·5 mgm. for the next three weeks; thereafter, their requirements having increased, they were given 1 mgm. daily and in a few cases the amount was increased for periods of one or two days if the animal began to lose weight rapidly. Most of the animals were killed after three months, but some after two and a half months.

On day 12 of the experiment, under ether anæsthesia, without incision, and using forceps resembling those described by Hertz[4], we attempted to fracture one fibula of each animal. This was not always successfully accomplished, as X-ray photographs showed, but the occurrence or not of a definite fracture did not appear to influence the changes described below. The X-ray photographs showed that in many cases some damage was inflicted on the tibia as well as on the fibula.

Results. X-ray photographs showed no signs of reopening of the callus in any group. Groups 1 and 2 appeared completely normal and Groups 3 and 4 showed no signs of rickets that could be detected macroscopically or with X-rays. Animals in Groups 3 and 4, that is, those low in vitamin C, displayed conditions which seemed to us of particular interest.

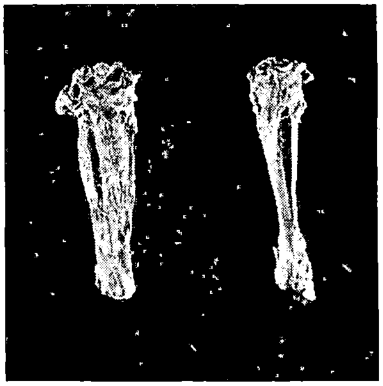

Fig. 1. LEFT: HYPEROSTOTIC LEFT TIBIA AND FIBULA OF A GUINEA PIG OF GROUP 4. RIGHT: THE NORMAL RIGHT TIBIA AND FIBULA OF THE SAME GUINEA PIG.

(1) A hyperostosis of the tibia and fibula (Fig. 1) occurred in three of the four in Group 3, and in a smaller proportion of cases in Group 4. Hyperostosis was frequently, though not always, associated with the changes in the muscles and the stiffness of the knee joint to be described below. Transverse sections (Fig. 2) showed that the original bone had suffered much porosis. It was surrounded by a great mass of trabeculæ of poorly developed new bone, which occupied a wide area beneath the periosteum. Resorption of the old bone and deposition of new periosteal bone were proceeding simultaneously. The occurrence of hyperostosis in the tibia as well as in the fibula probably reflects injury to both these bones by the fracture forceps. Mouriquand and colleagues[5,6] described periosteal thickening in uninjured guinea pigs suffering from a chronic deficiency in vitamin C; in our experience there is a definite association with injury, but in an uncompleted experiment we have at least one case of hyperostosis in a limb not injured more seriously than is unavoidable by handling in taking X-ray photographs.

(2) In a number of animals of both Groups 3 and 4 the muscles of the hind legs were greatly swollen, of tougher consistency than usual, while individual muscles could only be separated with great difficulty and felt slippery to the touch. Sections showed an abnormally large amount of a very loose connective

tissue within the muscles and between them ; obvious changes in the muscle fibres themselves seem uncommon. In many of these cases there are hæmorrhages in the muscles. Muscles of other parts of the body always seemed normal, except for some hæmorrhages. In at least one case the muscles were affected in the manner described on the unoperated as well as on the operated side.

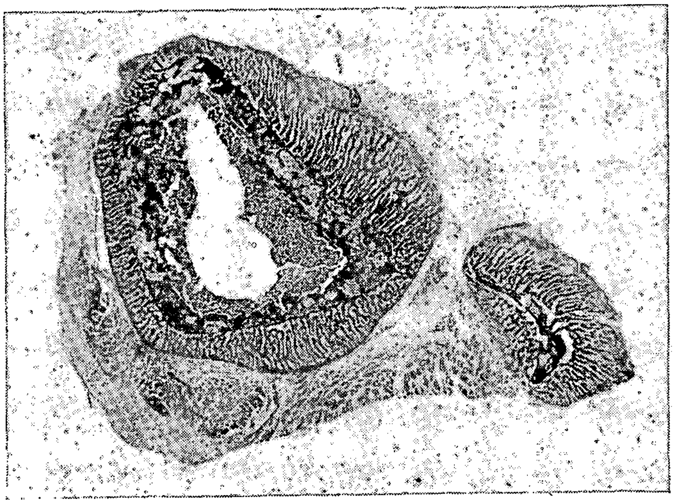

Fig. 2. TRANSVERSE SECTION OF THE HYPEROSTOTIC TIBIA (RIGHT) AND FIBULA (LEFT) OF A GUINEA PIG OF GROUP 4. THE OLD BONY CYLINDERS SHOW A HIGH DEGREE OF POROSIS BUT ARE SURROUNDED BY A WIDE ZONE FILLED WITH RADIATING TRABECULÆ OF NEW BONE.

(3) The hind legs of all animals in Group 3 and of a few of those in Group 4 were found to be fixed in flexion, and could not be fully extended, and attempts to extend them evidently caused pain. This condition was first noticed during the third month, but in experiments now in progress it has had an earlier onset. In some cases it was present in the uninjured as well as in the injured leg, and this is confirmed in the new experiments. It may possibly be due to the condition in the muscles described above, but more probably to ankylotic changes in the knee joint, such as have been described by Mouriquand[5,6] in chronic vitamin C deficiency.

Comments. The intimate pathology of these findings will be dealt with in a later publication. It is certain that all three of the conditions described occurred only with prolonged partial deficiency in vitamin C and irrespectively of whether the animals were supplied with vitamin D or not. We think it probable that the periosteal thickening is associated with the separation of the periosteum from the bone surface, and that this was in part caused by the weakening of the collagen fibres attaching it to the bone and in part to the subperiosteal hæmorrhages which, as is well known, occur in vitamin C deficiency.

The immediate interest of the observations lies in the occurrence of pathological changes during mild deficiency of vitamin C which began in the later stages of recovery from an injury, but which was not sufficient to cause death or severe external signs of scurvy, other than retarded growth. Although, apart from retarded growth, the animals appeared normal, there were nevertheless severe changes in muscle and bone which had been exposed to injury as described above. It may be noted that, in the latter part of the experiment, owing to their increased weight, the animals were given ·1 mgm. of ascorbic acid daily, and that this was not sufficient to prevent the changes described.

Assuming that similar causes may produce similar effects in man, the results emphasize the desirability for a liberal supply of vitamin C to patients recovering from injury to bones and muscles. The observations made by Ellis[7] of periosteal thickening in both ulnæ of an infant which he considers to have been deficient in vitamin C suggest that this assumption may be well founded.

Further experiments are in progress.

Summary. (1) The effect of a partial deficiency of vitamin C on the healing of injuries to bones and muscles in guinea pigs was studied. No apparent clinical sign of an impaired nutrition was evident other than retarded growth. No reopening of healed fractures was observed.

(2) Many of the guinea pigs recovering from injury to bone and muscle on diets partially deficient in vitamin C (or partially deficient in vitamin C and almost wholly deficient in vitamin D) showed the following conditions : (*a*) a very marked overgrowth of sub-periosteal bone of a histologically inferior type, while the original bony cylinder showed a typical scorbutic porosis ; (*b*) a swelling of the leg muscles involving an overgrowth of the inter- and intramuscular connective tissues ; (*c*) an immobilization, possibly ankylotic, of the associated knee joint.

Attention is directed to the possible clinical significance of these findings in the treatment of injuries to bone and muscle in man.

[1] Israel, A., and Fränkel, R., *Klin. Wschr.*, 95 (1926).
[2] Schilowzew, S. F., *Dtsch. Z. Chir.*, **209**, 320 (1928).
[3] Roegholt, M. N., *Arch. klin. Chir.*, **168**, 783 (1931–32).
[4] Hertz, J., "Studies of the healing of fractures with special reference to the vitamin content of the diet", Oxford University Press (1936).
[5] Mouriquand, G., Tête, Wenger, Viennois, *C.R. Acad. Sci.*, **204**, 921 (1937).
[6] Mouriquand, G., Dauvergne, Tête, Edel; *C.R. Acad. Sci.*, **210**, 515 (1940).
[7] Ellis, R. W. B., *Proc. Roy. Soc. Med.*, **32**, 139 (1938–39).

AGRICULTURAL RESEARCH IN GREAT BRITAIN

THE Agricultural Research Council, which is the body responsible for the co-ordination of agricultural research in Great Britain, has issued a report* on the investigations now in progress.

The first part of the report deals with the organization of agricultural research, describing the role of the responsible authorities, namely, the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland, the Agricultural Research Council, and the newly formed Agricultural Improvement Councils, one for England and the other for Scotland. The Improvement Councils have been created to advise the Minister of Agriculture on problems needing research, and on the testing of promising results with the view of their introduction into farming practice. It may not be easy, at this stage, for an observer to understand the necessity for creating an additional body to deal with agricultural research in Great Britain, and why the functions of the Improvement Councils could not be carried out by the Agricultural Research Council and the Technical Development Committee of the Ministry. The report, however, indicates the useful work already performed by the Improvement Councils, and considers that they will play a very useful part in aiding research and putting results into practice.

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* Agricultural Research in Great Britain. Pp. 100. (London: H.M. Stationery Office, 1943.)

The report also deals with the institutions and organizations carrying out research, such as the research institutes, some of which are under the direct control of the Ministry of Agriculture, and others of the Agricultural Research Council; the university and advisory departments also play an important part in agricultural research, and their roles are described.

The summary of investigations has been classified on a subject basis; the work of a particular institute may thus appear in more than one section of the report. This does not, however, detract from the usefulness of the report or its convenience, because many institutes have been formed to carry out research on a particular crop or subject. As is to be expected, the work in progress has been greatly influenced by war needs, much fundamental long-term work having been suspended in order to secure information necessary for the immediate food production campaign. The Chemistry Department at Rothamsted, for example, now devotes much attention to the estimation of national fertilizer requirements and to the development of efficient methods for allocating fertilizers at varying levels of imports and supplies. Experiments are also in progress there to test new sources of phosphates, town refuse as manure, the value of salt as a substitute for potash, etc. An example of large-scale war-time work is provided by the work of the advisory departments in carrying out the large number of soil tests for lime and phosphate in order to ensure that these important fertilizers reach the soils most in need of them; in 1942 more than 113,000 tests were carried out. These tests aid research because of the value of their results in the mapping of soils. As a contrast to the types of investigation mentioned above may be quoted problems of a more limited nature such as the investigation of the control of weeds in onion crops by chemical methods, in order to reduce the heavy labour involved in the hand weeding of the crop.

There are many investigations described in the report which, though they are of a long-term nature, will yield results of value in the present food production campaign. The grassland investigations in progress at the Welsh Plant Breeding Station, Aberystwyth, and at the Grassland Improvement Station, Dodwell, will result in the gaining of knowledge and experience, which will help to establish sound systems of ley farming under various soil conditions after the War. These investigations, however, have already yielded results which assist ley farming, with its system of restorative crops; this helps in the all-important problem of keeping the land fertile and clean under war-time cropping.

The importance of milk in the national diet of to-day adds interest to the investigations in progress on the yield, nutritive value and keeping qualities of this product. These are carried out at the National Institute for Research in Dairying at Reading, the Hannah Research Institute, Ayr, and at the provincial advisory centres. The effects of certain diseases, such as mastitis, on milk are also being studied. The investigation on mastitis in relation to dairying forms part of a larger programme of research planned and co-ordinated by the Agricultural Research Council, a section of which is undertaken at the Council's field station at Compton. Investigations on other diseases of dairy cows, forming part of the programmes of work at various animal health research centres, also have an important bearing on the milk situation.

Mention should be made of the co-operation between the Agricultural Research Council, the Department of Scientific and Industrial Research and the Medical Research Council. The three organizations have been created to promote and co-ordinate scientific research on all problems affecting the life and activity of the nation as a whole. It can be readily understood that the relations between these organizations should be very close, since agriculture touches the processing and storage of agricultural products on one hand and medicine or public health on the other. The report illustrates the close relations existing between these three bodies, and summarizes some of the problems that are under investigation by the last two, and that are at the same time of interest to the Agricultural Research Council.

The extensive field of research work covered by the various organizations has been dealt with in an effective manner, and the classification is clear. The only defect is that referred to in the report itself, namely, that there is little indication as to the relative weight of the attacks on each of the problems listed. As explained in the report, this is difficult, if not impossible, to accomplish in view of war-time conditions regarding shortage of staff, etc.

AMERICAN INSTITUTE OF PHYSICS

A SURVEY of the first ten years of the work of the American Institute of Physics has been presented in a ten-page "Report to Physicists" (*Rev. Sci. Inst.*, 13, 471; 1942). The tendency with the growth of physics is for different groups to 'split up' and form a large number of separate societies. The American Institute was planned rather to promote co-operation. A joint committee representing the American Physical, Optical, Acoustical and Rheological Societies recommended that an American Institute of Physics should be founded "to provide a medium to combine their strength for common objectives, to study the publication problem, to obtain financial support and to halt the dispersive trend of physics". The Institute was formally founded in 1931.

A penetrating analysis of the cost of publication of scientific journals led to a proposal to combine current journals into a single large journal of physics with specialist subdivisions. Practically, however, this left out of account the established tradition and names of the journals, and disregarded the 'society' pride and sense of responsibility with which they were endowed. The proposed change was too drastic to entrust to a new untested organization. As a compromise, the separate journals were brought into a single routine of publication without any change of sponsorship. Unlike the Institute of Physics in Great Britain, it has no individual members and collects no subscriptions in the usual sense. It is a non-profit, educational corporation, the only members of which are the five founder societies, each as an entity. The American Association of Physics Teachers forms the fifth member. The Publications Department issues eight periodicals, the *Physical Review, Reviews of Modern Physics, Journal of the Optical Society of America, Journal of the Acoustical Society of America, American Journal of Physics* (formerly the *American Physics Teacher*), *Review of Scientific Instruments, Journal of Applied Physics* (formerly *Physics*) and the *Journal of Chemical Physics*. In 1941, 6,834 pages were published containing approximately 52 million type characters, each of which was checked three or more times by the Institute publication staff.

The Institute has succeeded in obtaining much-needed new funds for publishing and other services helpful to physicists. During the ten-year period from 1932 to 1941, about 350,000 dollars of 'new' income was obtained in addition to about 450,000 dollars collected by the Societies as members' subscriptions. Associates of the Institute pay each a subscription of 175 dollars per year. The associate membership in 1942 consisted of twenty-six well-known industrial organizations.

Attention is directed to the necessity of advertising physics. "Physics is a human activity and, like all others, depends upon the interest with which people in general regard it. In the long run, solid achievement is the best road to general recognition, but even achievement can be overlooked, taken for granted, forgotten through familiarity, or credited to the wrong agent. Unless physicists and their friends occasionally take positive steps to demonstrate and call attention to the advances and services of physics, public attention will readily be diverted to fields which are better displayed and more repeatedly praised." Several readable books about physics and its applications have been written and published at the instigation of the Institute as part of its education and publicity plan. A number of successful symposia have been arranged to present the capacities of physics to well-selected audiences. Noteworthy is the conference on biophysics held in Philadelphia in November 1937, which was attended by some eight hundred biologists, medical men, chemists and physicists, providing a valuable excursion into a borderline subject. This conference was expertly reported by the newspapers. The Institute sponsors such symposia to direct the attention of the public and its industrial and educational leaders to physics by showing its advances and their applications. With the world of business the Institute has established an advantageous connexion for physics and research in general through the National Association of Manufacturers. Encouragement has also been given to the Research Advisory Service extended by a number of banks in various cities to their customers. By these means, industrialists hear an advocacy of research from other industrialists and from bankers "often to be better persuaded than when they hear such a message from research men themselves !"

The War has brought many new problems in which the Institute has been able to act as an established central organization. As to the future, much attention has been given to the training and opportunities for service of the future physicist. The report forms an impressive account of ten years outstanding achievements in physics and in service to the community. The founders of the Institute were concerned with a growing tendency for physics to 'split up'. This same tendency unfortunately extends to many other human activities. The War is, however, already bringing into closer contact British and American physicists. Developments of transport are shortening time-distances so much that the end of the next ten years may well see a single international Institute of Physics, into which all the separate Institutes have merged as a section of a World Institute of Science.

W. H. G.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk are open to the public*)

Monday, April 5

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Miss Marjorie Sweeting: "Wave Trough Experiments on Beach Profiles".

Tuesday, April 6.

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. Thomas Sharp: "Town Planning and Public Health".*

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 3 p.m.—Sir Henry Dale, G.B.E., P.R.S.: "Chemistry in Modern Medicinal Treatment" (iv) "Present-day Developments".*

Institute of Physics (Electronics Group) (in the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 6 p.m.—Dr. J. H. Fremlin: "Physics and the Static Characteristics of Hard Vacuum Valves".

Wednesday, April 7

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Major R. G. Proby: "Agriculture To-day and To-morrow", 8: "Methods and Results of Land Reclamation in England".

Institution of Electrical Engineers (Wireless Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Edward Appleton, F.R.S.: "Radio Exploration of the Ionosphere".

Friday, April 9

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, South Kensington, London, S.W.7), at 4.30 p.m.—Dr. C. R. Burch: "A Technologist Looks at the Future" (Duddell Medal Lecture).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting. Prof. S. Chapman, F.R.S.: "Magnetism in the Sun's Atmosphere" (Presidential Address).

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Air Commodore Geoffrey Keynes: "The History of Blood Transfusion".

Saturday, April 10

Association of University Professors and Lecturers of the Allied Countries in Great Britain (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1)—Educational Conference. At 10 a.m.—"The Function of a University in a Modern Community": at 2.30 p.m.—"Methods of Practical Co-operation between Allied Universities in the Future".

Saturday, April 10-Sunday, April 11

Institute of Public Administration (joint meeting with the Institute of Industrial Administration and the Metropolitan Area Education Committee of the National Association of Local Government Officers) (in the County Hall, Westminster, London, S.E.1).—Conference on "Post-entry Training for Administration—the Need for an Administrative Staff College".

Saturday, April 10

2.30 p.m.—Discussion to be opened by Mr. E. S. Byng.

Sunday, April 11

10.30 a.m.—Discussion to be opened by Prof. Harold J. Laski.

Thursday, April 8-Monday, April 12

British Psychological Society (at St. Hilda's College, Oxford).—Extended General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Building Department and Lecturer in Civil Engineering—The Registrar, The Technical College, Sunderland (April 12).

Gas Engineer and Manager—The Town Clerk, Town Clerk's Office, Municipal Buildings, Library Street, Wigan (April 14).

Research Assistant—The Secretary, Animal Diseases Research Association, Moredun Institute, Gilmerton, Midlothian (April 26).

Psychologist (woman) at the Harrow Child Guidance Clinic—The Clerk to the County Council, "R.2", Middlesex Guildhall, Westminster, London, S.W.1.

Science Graduate, capable of abstracting foreign articles on technical horticulture into correct English—The Deputy Director, Imperial Bureau of Horticulture and Plantation Crops, East Malling Research Station, Maidstone, Kent.

University College of Science
22/7/43
Physics Dept.
92, Upper Circular Rd, Calcutta.

NATURE

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DEVELOPMENT OF COLONIAL DEPENDENCIES

THE report on the operation of the Colonial Development and Welfare Act, 1940, to October 31, 1942, and, more especially, Sir Frank Stockdale's report on Development and Welfare in the West Indies, 1940–1942, give a very clear picture of the ideas which are inspiring Great Britain in the discharge of its responsibilities to its Colonial dependencies at the present time. There can be no question that the future of the world depends largely on the ability of Britain and the United States to understand one another and to work together, and questions of Colonial policy must inevitably involve a searching test of that capacity for co-operation. It would be most unfortunate if Colonel Oliver Stanley's speech at Oxford on March 5, with its firm rejection of international administration of the Colonies, were misinterpreted as implying the denial of the rights of third parties to take an interest in the Colonial policy of the Colonial Powers.

Colonel Stanley appears to share the new conception of social and economic purpose to which Prof. W. K. Hancock directs attention in his "Survey of British Commonwealth Affairs", and which forms the theme of some striking sections in Lord Hailey's recent booklet, "Britain and her Dependencies". The conception of the welfare of nations, as Prof. Hancock truly says, brings hope. "It offers a new stimulus to take the place of the moving frontiers; it promises to an expansionist society the means of living in harmony with its own nature, even in an age when geographical expansion has reached its limits. A struggle to raise the standard of the depressed classes and the depressed areas of the world could have a dynamic effect comparable with the discovery of a new America."

This is the new conception into which the new programme of Colonial development and welfare naturally fits, and in his close analysis, first of the evolution of the settlers' frontier in Southern Africa, and then of the traders' frontier in West Africa, Prof. Hancock shows how large a place must be taken by scientific research and inquiry, the incompleteness of slogans and programmes and the necessity for a new attitude and new methods, above all for the formulation and pursuit of a clear policy in place of hesitation and pusillanimity. Sir Frank Stockdale's report is in striking harmony with Prof. Hancock's observations on West Africa. The problem of the West Indies is at bottom one of poverty, aggravated by movements in world economy which have heavily damaged their trade, and the guiding principle of Sir Frank Stockdale's administration of the West Indian Welfare Fund is the stimulation of capacity to earn an income, not merely the provision of income. In regard to health matters, special attention has been given to the development of health units and to the control of malaria, which constitutes a serious economic problem in some areas, yaws and venereal diseases. The approved scheme for Jamaica, for example, provides for improving and extending the existing procedure for malaria control; establishing a research unit to investigate malaria and mosquito problems not only in Jamaica but also in British Honduras, the Turks and Caicos Islands and the Cayman Islands; and experiments and demonstrations in malaria control and land benefaction and for testing new methods, by the Medical Department and research unit in collaboration. Greater attention is being given to sanitation and to improved diet, as well as to better housing conditions and improved water supplies, which are required to improve health conditions.

In regard to agriculture, the Comptroller is devoting considerable attention to soil erosion, which presents a constant danger of irremediable impoverishment to many of the islands. A further objective has been the development of mixed farming systems to maintain or improve soil fertility and to increase the consumption of milk, the present most urgent nutritional need of the people, simultaneously displacing the dependence on imported tinned luxuries. Nutrition, in fact, has taken a high place in the planning of agricultural schemes, and in regard to land settlement the necessity of a more fundamental approach is stressed.

The report repeatedly emphasizes the importance of research, and while the proposals, which can only be implemented after the War, are not complete, the centralization of fundamental and long-term research in association with the Imperial College of Tropical Agriculture, Trinidad, is regarded as vital to the future needs of agriculture in every part of the West Indies. The proposals provide for research in plant-breeding for the major economic plants and food crops; for soil surveys of all the potential agricultural areas of the West Indies which have not yet been adequately surveyed, as well as soil-conservation studies. Provision for the development of animal husbandry and the breeding of efficient breeds of cattle, small stock and poultry which can stand up to the West Indian climate is also proposed, as well as entomological investigations, particularly in regard to foodstuffs. Grants have been approved for schemes for low-temperature investigations on the storage of fruit, vegetable and animal products, and for fisheries investigations; the Sugar Manufacturers Association will maintain its own research organization during the War, and proposals for sugar technology and research into new uses for the sugar-cane and its by-products are deferred.

Concentration of all these lines of research in Trinidad is neither practicable nor desirable, although Jamaica is the proposed site for the central research stations for animal breeding and for the breeding of bananas immune to Panama and Cercospora disease. There is no intention of moving the West Indian Sugar-Cane Breeding Station from Barbados. A scheme is in operation for investigation of the insect pests of food crops and problems of food storage in the Windward and Leeward Islands; and in connexion with endeavours to divert a proper proportion of effort from an export trade in sugar it is noted that in Trinidad the ruin of large areas of cocoa by witchbroom disease has rendered the sugar-cane the only immediate alternative cash-crop, and that derris is a promising alternative crop for the large sugar estates of Trinidad and Jamaica.

Although Trinidad now derives most wealth from its mineral oil resources, the majority of the population is dependent on agriculture, and the economic position of the producer of agricultural exports in Trinidad is probably the most difficult of the West Indies. The local Government has therefore appointed a committee to formulate a long-term policy for agriculture in the Colony, to lay down the broad lines for research, and, in general, to submit comprehensive proposals for the betterment of agriculture. The report of this committee is not expected before the end of the year. Detailed investigations on the sea fisheries of Barbados, Trinidad and British Guiana are in progress, and in this field there is special reference to co-operation with the United States Fish and Wildlife Service (Department of the Interior), and further co-operation has been promised by the United States authorities in a development scheme for commercial fishery research and to institute food-fish production projects.

A stimulating section of the report on social welfare pays tribute to the constructive work of Jamaica Welfare Limited, and provision for similar work with grant aid under the Colonial Development and Welfare Act has been recommended for certain other Colonies. The feature of this section is its lucid discussion of first principles, objectives and methods. The economic future of the West Indies rests with agriculture, and both in welfare work and education Sir Frank Stockdale is concerned to check the marked and dangerous drift from the country to the towns. The primary problem is how to enable the people to live on the land to their own satisfaction, and a particularly intimate relation between the agricultural and social welfare services is thus required. Weaknesses in social structure have convinced the agricultural experts of the importance of welfare work, just as the weaknesses in economic structure have convinced the social administrator of the need for better agriculture.

A social welfare programme for the West Indies must provide for three requirements: first, the coordination of all existing public and voluntary social services in the promotion of the welfare of the people of each Colony; secondly, the active encouragement of changes in social institutions and habits when this is desirable; and thirdly, the more effective administration of those social services which are apt to be neglected at present because they cannot be fitted into the responsibilities of any of the more important Government Departments. The most obvious gap in the apparatus of social administration in the West Indies is machinery for research. Without it, objective information about social conditions cannot be obtained and a secure basis for social policy is lacking. A few social surveys of the type familiar in Great Britain would encourage dispassionate thinking and objective fact-finding about social problems, as well as make it easier to introduce modern techniques of accurate measurement of size and intensity, and to promote clarity and coherence in social policy.

Research is also a necessary aid to the training of social workers and in education, where considerable modifications in the system will be required if it is to fulfil the requirements ; the crux of reconstruction is the training of the teacher, especially in outlook. While the administration of the Fund is already looking ahead to the encouragement of higher education and the training of teachers, it recognizes as the first real need the reform of the existing system of education, the improvement of buildings and staff and a modernization of the teaching to provide the foundations of an education which will fit the children for wider community interests and activities when they grow up. Sir Frank Stockdale believes in training the young for the kind of life they will naturally live in their own economic environment.

Lord Hailey's booklet, however, shows that much remains to be done. The first charge on the resources provided by the Colonial Development and Welfare Act should, in his opinion, be improvement of conditions of subsistence and production, and development of the simpler secondary industries. The growth of agrarian indebtedness is an evil which must be checked if it is not to become as grave an economic menace as in India, Burma and Egypt. There is need for firm and comprehensive treatment. Again, he suggests that in view of the insufficient revenues of the social services, the local administrations should take a sufficient share of the profits of foreign enterprise. The whole question of the taxation of undertakings operating in the dependencies must clearly, as he proposes, be re-examined after the War. These economic questions lie in the very forefront of discussions on the practical steps which should be taken to achieve the economic objectives of the Atlantic Charter, to which Great Britain is committed.

The place of the Colonial dependencies in such a world political association as Mr. Morrison recently sketched is obvious, and Great Britain is moving in the right direction, as these reports have shown. Moreover, Mr. Morrison's speeches, notably that at Newcastle on January 10, have done much to stimulate interest and clarify thought on the positive aspects of Colonial policy, and to prepare public opinion for that larger expenditure which is undoubtedly called for if these objectives are to be realized.

It should be remembered, moreover, that though economic questions bulk large and our constructive social and economic policies have, as Mr. Morrison observed, not matched the political enlightenment and humane integrity of our Colonial administration, there are fresh political and administrative issues that have to be faced. Regional schemes and grouping are already here, and their implications must be explored. We must recognize that Colonial partnership cannot attain full fruition within the framework of the British Commonwealth alone, and whereas international administration or responsibility may be rejected, the problem of working out new methods of international co-operation in research, supervision and control remains. Again, we must at least face the question whether the dependencies could be assured of the substance of self-government by some method other than that we are now pursuing. Such a study might show that there is after all no alternative ; but it would be regrettable, to say the least, if we found ourselves in difficult country at the end of the journey, should we also have cause to reflect that we had not even considered the direction in which our path was leading us.

It is such reasons as these which give pertinence to the discussions on the Colonial Service and its reform, and to the proposals for a Colonial Development Board, in recent Parliamentary debates and in the booklet "Downing Street and the Colonies" recently issued by the Fabian Society*. The adequacy of the machinery of government by which effect is to be given to the new policies must come under review, and although the idea of a Colonial Development Board has been rejected by the Government, that of an advisory board has again been urged by Squadron-Leader P. Donner, and the proposal for a standing parliamentary committee on Colonial affairs is too valuable a means of increasing interest and educating Parliament itself in Colonial affairs to be lightly rejected. The greater provision for Colonial studies in the leading universities of the British Empire, as urged by Prof. Daryll Forde, Dr. Julian Huxley and Miss Margaret Perham, would be a further factor in the education of public opinion, and in teaching and training members of the Colonial service, as well as in co-operation between the Colonial Office and Colonial Governments in carrying out the long-range research so urgently needed in such problems as Colonial law and land tenure, the relation between local government based on tribal traditions and the European forms of central and municipal government.

Much is being done by the Government already to meet the requirements of the situation, and even Colonel Stanley's review did not cover the whole field ; he was unable, for example, to refer to the work of the new executive body, the Colonial Products Research Council, of which Lord Hankey is chairman, and which is destined both to promote the welfare and prosperity of Colonial peoples and the Colonial contribution to the welfare and prosperity of the British Empire and of the world as a whole. The very fact that the welfare of the Colonial empire is so closely linked with that of the world and that their long-term interests are the same makes it imperative that the task of educating, not only the people of Great Britain, its dependencies and the Dominions, but also the United Nations, as to the British achievements—of which we have a right to be proud, in spite of all shortcomings—should be undertaken with energy and imagination as a part of the task of building the peace. If the British contribution to world order, that great factor of stability and progress to which Mr. Morrison referred, is to be made active, steps must be taken to remove the misconceptions of the British Commonwealth which our enemies are only too sedulous in fostering. That is a task in which every good citizen can and should play his part; for without it the definite action and discussions before Governments to secure concrete agreement on the machinery by which effect is to be given to post-war collaboration between the United Nations as well as on the practical policy to be pursued cannot be assured of the full support upon which their fulfilment depends. Intensive study is necessary to find a basis upon which durable Anglo-American co-operation is possible, and to devise a common approach and common action in world problems which neither democracy alone can solve. Visits such as that which Mr. Anthony Eden has recently undertaken can be of inestimable value in this way.

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* Downing Street and the Colonies. Report by the Fabian Colonial Bureau. Pp. 100 (London: George Allen and Unwin, Ltd., 1943.) 2s. net.

CHEMICAL BACKGROUND OF GROWTH

Biochemistry and Morphogenesis

By Joseph Needham. Pp. xvi+785+36 plates. (Cambridge: At the University Press, 1942.) 52*s*. 6*d*. net.

"BIOCHEMISTRY AND MORPHOGENESIS" consists of six hundred and seventy-seven pages each of about five hundred and fifty words. To these are appended (1) a glossary of eight pages, (2) one page on which are listed "Terms and concepts the use of which is not recommended", (3) a bibliography of seventy-six pages, a general index, an index of animals, and (4) an index of plants and an index of genes. The book, however, lacks an index of authors giving the page in the book on which the name of any author occurs. It follows that for every nine pages of matter there is one page of references. This fact alone attests the encyclopædic nature of the work. The book is obviously a very unusual one, and it may be said at once that no one who seriously concerns himself with the chemical aspect of development can afford to be without it.

The title is calculated to whet the curiosity of the reader, because it contains no implication of what the relationship between the two substantives linked by the word "and" may be; neither in the title dominates the other. The reader opens the book then with the expectation and hope of being informed upon the precise relationship between morphogenesis and biochemistry.

Dr. Needham sets out his own view of the plan of the book in the following words. "A discussion such as the following may be modestly compared to one of those narrow-gauge railway lines joining distant places, in which some European countries abound. Sometimes it runs along the well polished tracks of trunk communications, sometimes it strikes across country, winding through pastoral or wooded valleys with more originality; at one point it touches some obscure village, at another it pauses for a moment to make a junction with a main road. In the present state of our knowledge this is all that biochemistry can contribute. . . . The chemin-de-fer vicinal must not be mistaken for the routes of the great expresses." The routes of the great express (or is it the expresses themselves?) are other books: Hans Spemann's Silliman Lectures, Huxley and de Beer, the monograph of Daleg and so forth. The reader therefore visualizes Needham's work as a line piloting the train of biochemistry across these various tracks of morphogenesis. What the biochemist can say about each and about a number of lesser but interesting matters is said, and the *chemin-de-fer vicinal* even has some branches of its own. The light railway 'motif' applies not only to the matter in, but also to the format of, the book. It is not divided in chapters, it just runs. Each paragraph is numbered and the arrangement of the material is indicated by the numbering. Take, for example, paragraph 2·335. The 'two' indicates that the paragraph has to do with "morphogenic stimuli"; the 'three' in the first decimal place, that as a subdivision of 'two', the paragraph deals with amphibian development and general principles; the second 'three' as a sub-sub-division, that it is concerned with the vertebrate axis; and lastly the 'five' that as a sub-sub-sub-division it deals with the endoderm and mesoderm. All this you find in the 'contents' at the commencement of this book. I can imagine this method as being very helpful when the reader has accustomed himself to it, especially when the book is used for reference. The method will be new to most readers of biology and has, I believe, been taken over from mathematical works in which it found early exponents in Whitehead and Russell.

Turning from the manner to the matter, the first ninety pages deal with what the author calls the "morphogenetic substratum". This part concerns itself with such subjects as the constitution of the ovum, the egg and its environment, embryonic nutrition, the placenta and so forth. Being rather of the nature of a prelude, it is a descriptive account of the egg and its nourishment over the range of animal life, written from the chemical point of view; but it is much more than a mere compilation, for the author has worked over much of the data which he cites and presents in a way which emphasizes his own interpretation of it. To take an example, anyone wishing to look up what is known about the passage of substance across the placental barrier will find all the references in Needham's book, together with his own view—that the placenta is a rather complicated ultra-filter—a view which not everyone will accept.

My guess is that the real interest of the author commences to reveal itself on p. 98, when he passes from a discussion of the milieu of his subject to the subject itself.

Pp. 98–175 (§ 2·05–2·34) contain an informing description of the general principles of development at the early stages: induction competence, regional development, gastrulation, the primary organizer and so forth, but they contain approximately no biochemistry. In the pages between 176 and 188, the reader gets to something more specific from the chemical point of view, namely, a description of the experiments of Needham himself and others on the induction of neural tubes in gastrulæ by the injection of definite chemical materials. The train is arrived at a station.

At paragraph 2·351 it drifts off again into the country. The author embarks on a discussion of the metabolism of the gastrula and pulls up at an important paragraph (2·353) on the role of sulphydryl in gastrular metabolism, followed by (2·355, there is no 2·354) one on the nature of inactive evocator complex, in which protein complexes with polysaccharides, lipins, of polysaccharides with lipines and so forth are discussed. At this point therefore such bodies as aneurin (vitamin B_1), flavo-protein (yellow enzyme), lactoflavin (vitamin B_2) co-carboxylase, and pyridoxin (vitamin B_6) come under survey. Perhaps the following paragraph may be quoted:

"We are thus coming to the general conception of combination with protein as the most important element in biological activity. An 'active' substance of low molecular weight will generally require combination with a specific protein in order that its activity may be manifested. It may be held in inactivated form on another, perhaps equally specific, protein. It may well be that the evocator has to be adsorbed on to a protein in order to carry out its effects, just as it has been previously liberated from an inactive combination. Unfortunately it is hard to picture exactly how the effect of the primary evocator is produced in competent cells. The problem will be referred to again in Section 3·5."

The discussion of organisms naturally leads to that of anomalies caused by their absence. Needham cites, for example, the effect of diets deficient in vitamin A causing blindness owing to the failure of the eye cups to develop. Thence the line leads to excess of organizers, to the consideration of twinning, terotomata and new growths.

The paragraphs under the general heading 2·38 (pp. 239–271) form perhaps the most arresting station on the railway. For this there are two reasons: first, the importance and scope of the subjects discussed; and secondly, the amount of definite biochemical knowledge which is applied to them. Here Needham links up sterols and bile acids with alkaloids, cardiac aglycones, anti-rachitic compounds, resin acids, saponin aglycones, adrenal cortex hormone, male sex hormones and androgens, female sex hormones and œstrogens, and these last with carcinogens and neurogens (primary evocator substances).

The sex hormones afford perhaps the outstanding instances of the production of definite changes in material form brought about by chemical bodies of established composition. To many readers the degrees of definiteness which the author can attain in his discussion of the physiologically, pathologically and pharmacologically active bodies built up in the sterol skeleton will be very welcome, and no one will grudge Dr. Needham the satisfaction with which, after discussing the constitution of vitamin D, he states, "It has been one of the triumphs of organic chemistry in recent years to show that other and more obscure substances of great biological activity also possess the sterol skeleton".

Ninety pages (pp. 340–430) are devoted to the relation between genetics and embryology, and these will be read with particular interest by many. The following sentence gives an idea of the drift of this part of the book: "It might even be said that the main difference between genetics and embryology is that in the former study only those inductors are described which are unable to pass through the cell-membranes of the cells in which they are formed, while in the latter, only inductors of more diffusible nature are described".

Of the four hundred pages which deal with stimuli, roughly 350 are concerned with vertebrate development; the last fifty chiefly with insects and echinoderms.

The final hundred or so pages of the text deal with respiration and metabolism. If I may be permitted to alter Dr. Needham's simile and regard the work as a railway of biochemistry traversing a population of morphogenesis, the railway started on p. 97 as a light one traversing a densely populated area; in the middle of the book it became a trunk line, still passing through a thickly populated district; towards the end it develops into a four-line track driving across fertile plains with but a cottage here and there. This part will be found extremely valuable to students of comparative physiology, but its claim to be connected with morphogenesis rests simply on the fact that life includes growth. There is very little about 'form'. The reader then will be informed about the respiration of the eggs of echinoderms, of worms, of molluscs, of arthropods, of fishes, of amphibia and of mammalian embryos. The important point is that the respiration of these forms is discussed in terms of recently acquired knowledge of respiratory pigments and respiratory enzymes.

Similarly with metabolism, Needham gives an excellent account of the subject in modern terms: the phosphorylation problem, protein metabolism in the higher and lower vertebrates and in the invertebrates, the growth-promoting factor, nuclein metabolism, lipin and sterol metabolism, pigment metabolism, pyrrol derivatives, lipochromes, flavines, pterines, melanin and many other topics. These discussions lead up to the organization of cell protoplasm.

The book leaves the reader with two definite impressions, namely, (1) the vast amount of work which has been carried out on the relation of development to the chemical processes responsible for it, and (2) how little of all this information is completely 'water tight'.

The following paragraph is typical of a great deal of the book.

"The active substances of the egg secretion have not so far been fully analysed. There is (1) the activator for the spawning male. This is believed to be glutathione or a similar sulphydryl compound in the case of polychætes (Townsend), but in molluscs its properties are different (Galtsov). There is (2) the activator for sperm motility. In echinoderms there seems to be a very volatile substance, since steam distillates of egg secretion are effective (Clowes and Bachman) as also propyl amyl, and cinnamyl alcohols. There is then (3) the substance responsible for the chemotactic attraction of spermatozoa (sometimes called aggregation); this has been identified by Hartmann, Schartau, Kühn and Wallenfels as the 978-pigment echinochrome, a polyhydroxy-naphthoquinone; though the claim is contested by Tyler. There is finally (4) the substance, or substances called 'fertilisin' by F. R. Lillie. This consists of two factors, the cleavage factor in the absence of which development cannot proceed, even if a sperm should penetrate the egg; and the agglutination factor which causes the spermatozoa to stick together around the egg-jelly".

The reader in time gets the impression that at times he is following a will o' the wisp, that he is hoping on the next page to find a direct and explicit statement that some important event in development is indubitably caused by some specific chemical compound of identifiable formula; too often he will discover that he has hoped in vain.

But Dr. Needham must not be held responsible for the state of knowledge of his subject, which is in the intermediate position between the simplicity of ignorance and that of complete understanding. He has performed a valiant task in marshalling the information which exists, a task which he has discharged conscientiously and skilfully. To him all interested in the subject at the level at which he treats it owe a debt of thanks for a welcome monograph.

J. BARCROFT.

PRECAUTIONS AGAINST CHEMICAL WARFARE

War Gases

Their Identification and Decontamination. By Dr. Morris B. Jacobs. Pp. xiii+180. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1942.) 3 dollars.

Gas Warfare

A Monograph for Instructors. Compiled by W. K. Fitch. Pp. 103. (London: Pharmaceutical Press, 1942.) 2*s.* 6*d.*

CHEMICAL weapons of war differ from other weapons in the degree to which it is possible for a well-prepared nation to protect itself against them. Probably the main reason why they have not yet been used in this War is that the Axis Powers know that our preparations for this form of warfare are very good. An important part of these preparations is the widespread dissemination of knowledge of the subject.

"War Gases", by Morris B. Jacobs, is an up-to-date review of the subject from the point of view of a chemist. It deals with all the important gases used in the War of 1914–18 and a few which were not. The physiological effect of each is briefly described, and estimates of its toxicity are quoted from various sources. In this section the concentrations are sometimes given as percentages, sometimes as parts per million and sometimes as milligrams per litre. It would be much easier to compare one gas with another, and one author with another, if concentrations were always given in milligrams per cubic metre. These units are small enough to avoid zeros following decimal points in most cases, and can be applied equally well to true gases, particulate smokes, and mixtures.

The main part of the book is devoted to details of the methods of taking samples of various materials without being poisoned, and of the methods of analysing them for war gases. The gas is placed in one of eight groups, or sub-groups, according to the presence or absence of hydrogen, sulphur, nitrogen, or arsenic, and tests for the individual compounds are then applied. The effects of war gases on materials of various kinds, and methods of decontamination, are discussed in some detail.

"Gas Warfare", by W. K. Fitch, covers a wider and more practical field. As editor of the *Pharmaceutical Journal*, the author is skilled in the presentation of data in a form which is likely to be attractive to those who have a scientific background, and as a member of the Home Guard he is supremely interested in practical applications. He has summarized the information published in the official handbooks and in larger text-books and presented it in a convenient and practical form. He discusses the history and properties of all the important gases, the weapons in which they are used, their detection and identification and questions of treatment and decontamination. He discusses the theory and detailed use of respirators, their efficiency and even the dermatitis which they may sometimes cause. He describes experiments on gas-proof rooms and methods of training, including the use of preparations which simulate the toxic materials without the danger. He devotes a chapter to the care of animals and gives a reasonably complete bibliography.

It is remarkable how much detailed information has been packed into this small book.

HISTORY OF SCIENCE

Studies in the History of Science

By E. A. Speiser, Otto E. Neugebauer, Hermann Ranke, Henry E. Sigerist, Richard H. Shryock, Evarts A. Graham, Edgar A. Singer, Hermann Weyl. (University of Pennsylvania: Bicentennial Conference.) Pp. v+123. (Philadelphia: University of Pennsylvania Press: London: Oxford University Press, 1941.) 9*s.* 6*d.* net.

THIS book consists of eight lectures on the history of science given at the bicentennial conference of the University of Pennsylvania. They are all of absorbing interest, although appealing severally to specialists and not to the general student.

The first lecture, dealing with Mesopotamia in the fourth millennium B.C., discusses the invention in ancient Sumer of what may be called writing. The records throw light on classificatory zoology, botany, geology and chemistry, and translations of them were made from Sumerian into Elamite, Hittite and other languages. The cylinder seal, the immediate ancestor of Mesopotamian writing, was, says Prof. E. A. Speiser, "first and foremost the Sumerian's mark of ownership". So the origin of writing was economic, and the result of a social order based on the recognition of personal rights. There is a marked contrast here with the civilization of Egypt, based on the supreme authority of the Pharaohs. The Egyptian script, perhaps borrowed from Mesopotamia, seems to present differences corresponding to the different cultures of these centres of civilization.

Prof. O. Neugebauer, in a lecture on fundamental concepts in ancient astronomy, discusses the determination of the hour as a unit of time and the way in which ancient astronomers dealt with the difficulty caused by the variable length of the day.

The next lecture has some interesting remarks about the two Egyptian medical papyri, the Ebers Papyrus and the Edwin Smith Papyrus. The former, a collection of recipes, was translated into English in 1937 by Dr. B. Ebbell, a Norwegian; the second, a surgical treatise, was published with translation and commentary by J. H. Breasted in 1930. The greater part of both is truly scientific, although here and there a piece of folk-medicine or superstition has been interpolated from far inferior sources.

Medieval medicine is discussed in an illuminating way by Prof. H. E. Sigerist. He shows how Arabs and Christians dealt with the problems raised by the adoption of an alien medical system that was only half understood, and finally achieved a medicine of their own by a process of assimilation and synthesis, followed by the revolt that accompanied the Renaissance.

The next two lectures, by Prof. R. H. Shryock and Prof. E. A. Graham respectively, deal with the birth of modern medicine and surgery during the last two hundred years. Medicine grew up with an increased attention paid to etiology rather than to syndromes; surgery depended upon attention to asepsis, anæsthetics and the avoidance of surgical shock. It is an old story, but the summaries here given are models of condensation, with many original observations scattered here and there.

The medical lectures are followed by Prof. E. A. Singer's exposition of what he calls a "logico-historical study of mechanism, vitalism, naturalism". When opposing schools of thought (for example, the mechanical view and the view that admits purpose in Nature) cannot settle their differences by experimentation, Dr. Singer claims that an application of his method makes plain "what the essence of this conflict is; why it should have endured through so long a past; whether it need continue unresolved through all the future". His account is closely reasoned and cannot be summarized, but students of the history of thought will certainly profit by a close study of it.

The book concludes with a lecture on the mathematical way of thinking, written by Prof. Hermann Weyl. He defines it as "that form of reasoning through which mathematics penetrates into the sciences of the external world—physics, chemistry, biology, economics, etc., and even into our everyday thoughts about human affairs, and secondly that form of reasoning which the mathematician, left to himself, applies in his own field". It appeals "to the light in our innermost self". The interrelation between the sciences and mathematics goes back to Parmenides, at the very birth of Greek thought, and formed the essence of the Platonic philosophy. In those early days a solution was found by denying the reality of phenomena, but by this time we understand better the conditions of the problem, and make of mathematics a willing servant to help our thoughts, instead of allowing it to become a tyrannical master to check or suppress them. W. H. S. JONES.

AN ANTHROPOLOGIST LOOKS AT THE UNITED STATES

And Keep Your Powder Dry

An Anthropologist Looks at America. By Margaret Mead. Pp. x+274. (New York: William Morrow and Co., 1942.) 2.50 dollars.

IN this book an American looks at the United States. Her attitude is that the American authorities deserted the cause in 1919 and that the great slump of 1929–30 and its consequences were the retribution for their lack of moral courage. We may leave our American friends to argue that thesis, and deal here rather with the author's efforts to delineate American characteristics, which, as she rightly says, must be used in any constructive work for a better world.

The United States depended very largely on old skills brought by emigrants from Europe and on ideas even of machinery largely derived from Britain, but developed those machines enormously and achieved the revolution 'from the craftsman to the assembly line', with gain and loss to be set against one another. The book has a rather antique picture of Europe, feudal and peasant, and the England set forth is emphatically not the middle-class industrial north, nor is there any trace of Scottish porridge or tasty Welsh rarebit! But the people of the United States probably surpass the British people generally in their worship of success, a success which in American circumstances must be measured by money even more than it is among us. To the United States have streamed immigrants from rural Europe, learning to speak a little broken American and yearning to see their children take a larger part in the glittering, if not always brave, new world; and these children making their footing, absolve the next generation from using at home the old language from Europe as a sort of skeleton in the cupboard. The grandparents are a drag on the younger people, who want their children to go ahead again another step.

So it went on while the West was open-armed to receive men, and the 'dustbowl' was not yet filled with ruin. The question that presses itself on us all is how the United States will react now that there is so much less chance of geographical expansion. The author pleads for initiative and adventure in the realm of social relations, and her experiences of the peoples of the East Indies and the South Seas help her to an objective point of view that makes the book lively and interesting. Her Americans are not pugnacious but, in the words of the old song, "We don't want to fight, but, by Jingo, if we do . . .". Her Americans, again, come from many sources and traditions; and yet there is the possibility of orchestrating these many cultures into a symphony that must be American in its reliance on individual energy and initiative, in its plans that give directives rather than goals, in its tolerance that enriches life, even if sometimes it delays decisions.

H. J. FLEURE.

SPANISH ASTRONOMICAL DATA

Anuario del Observatorio Astronómico de Madrid para 1943

Pp. 236. (Madrid: Instituto Geográfico, 1942.)

THIS work is very similar to those for previous years, the chief alterations being a table for interpolating the heliographic longitude of the centre of the sun's disk, and also small modifications in the elements of the principal planets to bring them up to recent determinations. In "Efemérides Del Sol, Para 1943" and "Efemérides De La Luna, Para 1943", in addition to other information such as times of rising and setting at Madrid, meridian passage, sidereal time for 0h. at Greenwich, and the moon's horizontal parallax, right ascension and declination of the sun and moon for each day are given for the times of transit at Greenwich, pp. 42–53, 89–100. These latter correspond to those in pp. 22–29 and pp. 156–171 respectively in the "Nautical Almanac", but in the work under consideration co-ordinates are given only to the nearest second of time in right ascension and second of arc in declination. The equation of time is not included with the solar coordinates but is given in a separate table to the nearest minute for 0h. each day at Greenwich. Another table supplies the sun's semi-diameter for every 10 days, the distance from the earth to the sun in terms of an astronomical unit to four decimal places, and also the sun's diurnal orbital motion on each of the ten days.

Among other features may be mentioned the elements of the planets, a special part being devoted to those of Pluto. These have been revised since the 1942 issue of the volume, and the more accurate figures by Bower at Lick Observatory have been included. Ephemerides for the planets for every ten days are given and also elements for the physical observation of Mars and Jupiter at intervals of four and seven days respectively. Comet workers will find a useful compilation of the elements of thirty-four periodic comets on pp. 162–163, and lists of star clusters, nebulæ, variable stars, double stars, and of stars occulted by the moon, visible at Madrid, etc.

Full explanations with examples of the application of the tables, etc., are given, and even an amateur astronomer who has just started on the subject will find little difficulty in using the work. M. D.

VALUE OF MICRO-ORGANISMS IN NUTRITION (FOOD YEAST)

By Dr. A. C. THAYSEN
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THE extensive study of the biology and biochemistry of micro-organisms, which has proceeded during the last two decades has greatly increased the appreciation of the important part which many micro-organisms play in the nutrition of man and animals.

During the nineteenth and early twentieth centuries the science of microbiology centred essentially around the pathogenic forms of microscopic life, and the demand for purity and sterility in foods of all descriptions became insistent and overriding; so much so, in fact, that even primitive communities who, like Europeans during the Middle Ages, had been accustomed to a daily intake of an appreciable quantity of micro-organisms, were relying largely on purified foods.

This change in dietetics is well illustrated by a reference to developments which have taken place in the brewing industry during the last century. To-day beer, with few exceptions, is supplied as a crystal-clear beverage from which all traces of yeast have been removed by filtration. During the Middle Ages beer, on the other hand, contained a large part of the yeast grown in it during brewing. When it is remembered that beer in those days was the most extensively consumed beverage, which was taken in considerable volume daily by all, even by quite young children, it will be appreciated that the consumption of yeast by the bulk of the population must have been very considerable indeed.

The same may be said to have been the case to an even greater and more significant extent in many tropical countries where freshly fermented and unfiltered, home-brewed beer or wine was drunk by the inhabitants in vast quantities during festive occasions until well-meaning but not equally well-instructed missionaries succeeded in banishing such beverages from the natives' diet. The effect on the health of the natives was bound to be profound, as will be appreciated when an outline has been given of the relevant biochemical properties of micro-organisms.

As is so often the case the work which led to an appreciation of the dietetic value of micro-organisms had its roots in an economic problem, the disposal of the surplus quantities of yeast which, year in year out, issued from the brewing plants of Europe and America. By the end of the nineteenth century chemical analyses had established that brewers' yeast contains a high percentage of protein. Attempts had also been made to utilize yeast as a protein concentrate in the feeding of cattle. Other suggested outlets for surplus yeast[1] (Klöcker, 1906) were as a substitute for coffee—a horrible thought—in soap manufacture and in the treatment of certain inflammatory conditions of man. However, though favourable reports on its value in such conditions were not lacking, and though equally favourable reports were from time to time given on its value as a protein concentrate in stockfeeding, little progress was made in the utilization of surplus brewers' yeast partly, no doubt, because of its bitter taste, due to its content of hop resins, and partly because its cost, as compared with that of other protein concentrates such as fish meal, was excessive. The disposal of surplus yeast remained an economic problem of some importance to the brewing industry.

When the War of 1914–18 broke out, Germany and her allies found themselves cut off from overseas sources of protein concentrates for stockfeeding, and attention was therefore again turned to the utilization of brewers' yeast. Furthermore, in anticipation of greatly increased demands for protein concentrates, investigations were started by the Central Powers to explore the possibility of applying the observations of Pasteur and Ducleaux and later of Märker[2], that protein can be synthesized by yeast from inorganic nitrogen, including ammonium salts. Delbrück and his collaborators had previously[3] worked out a method for the synthesis of protein from ammonium salts by growing yeast in worts containing sugars as the only organic food substance. But this method was uneconomic because of the low rate of synthesis secured.

By 1915 Hayduck[4] was able to report that he had succeeded in synthesizing protein from ammonia on a technical scale with much better yields than hitherto by using a type of yeast—presumably a species of Torula—which produced little alcohol and grew well in the absence of organic nitrogen. A yeast product of this type was put on the market in Germany at the time and recommended by its manufacturers as suitable for human consumption. However, large-scale production was apparently not proceeded with, probably owing to lack of sugars in Germany at the time. The digestibility of the "mineral yeast", as the product was called, was evaluated by Völtz[5], who found it to be of a high order.

During the same period, and in Great Britain, another type of protein from microbial sources was tried successfully in the rearing of pigs. The material was obtained from the bacterial residues accumulating during the manufacture of acetone and butyl alcohol by the fermentation of cereals. This bacterial residue, when fed to pigs on a restricted war diet, invariably gave a better rate of growth in the animals than the standard diet. At the time, no attempts were made to investigate the reasons for the observed beneficial effect, but it appears justifiable, in view of subsequent knowledge, to attribute it to the B vitamins and the high-grade protein contained in the bacterial residue.

With the end of the War of 1914–18 and notably since the start of the twentieth century, great interest has been taken in the dietetic value of micro-organisms both from the point of view of their protein content and afterwards of their vitamin content. Most of this work has been done on yeast, starting with the publications of Osborne and Mendel[6], who showed that rats thrive well on a diet containing brewers' yeast as the sole source of protein. Generalizing the various observations made, it may be claimed that yeast protein—the most extensively studied form of microbial protein—possesses a nutritive value only slightly inferior to that of a good animal protein. Of special interest are the observations of Macrae and his collaborators[7], who not only confirmed the earlier observations on the value of yeast protein but also showed that a comparatively small addition of microbial (yeast) protein to a diet containing only cereal protein of low dietetic value, such as maize protein, greatly increased the value of the latter in the rearing of pigs.

As regards the vitamin content of micro-organisms, work done during the last twenty years has shown that these organisms constitute the most potent source of the water-soluble B vitamins known, and that many micro-organisms, including some forms of yeast, are able to synthesize B vitamins from inorganic sources, provided that carbohydrates are supplied for their growth.

Taken in conjunction with Macrae's observations on the value of microbial protein, it can now be appreciated how serious must have been the effect on the health of many native peoples of tropical countries to interfere with their consumption of home-brewed beers. For the diet of these peoples is essentially one of cereals, and frequently of cereals in which the protein is of low dietetic value. It is not to be wondered at that deficiency diseases attributable to lack of a vitamin B intake have increased in tropical countries with the sophistication of the native diet.

Once it had been established that micro-organisms form a valuable source of B vitamins and of protein of high nutritive value it became important to develop methods for the large-scale production of this concentrate in order to make it available for animal and human feeding purposes. Not unnaturally attention was again attracted to the surplus supplies of brewers' yeast, but the results achieved with this material were not always satisfactory, since the bitter taste of the yeast had to be removed to make it palatable. This was done by washing either with water or with dilute alkalis, a treatment which led to the destruction of much of its vitamin content. Nor were the available quantities of brewers' yeast likely to cover more than a fraction of the requirements likely to be needed in such countries where vitamin B deficiencies are seriously felt. To meet such a demand a new method of production had to be devised either along the lines adopted during the War of 1914–18 in Germany, or by any other method which might be found superior.

At the request of the Agricultural Research Council and the Scientific Committee on Food Policy, this work was undertaken by the Department of Scientific and Industrial Research in the microbiological section of its Chemical Research Laboratory at Teddington, where investigations on this problem have proceeded since 1940. In Germany, t is understood, parallel investigations have been going on simultaneously, but there the difficulty has arisen of a shortage of available carbohydrates, of which no supplies exist beyond the hydrolysate of waste wood—an entirely uneconomic raw material n normal times. Within the British Empire, on the other hand, a variety of cheap and surplus carbohydrates are always available in districts where the demand for the protein-vitamin concentrate is likely o be permanent. This has made it possible for the British investigators to concentrate their work on devising methods for the cheap production of the oncentrate, an all-important aspect, seeing that the sections of society who are in greatest need of supplementary B vitamins are usually those who cannot fford the consumption of the standard sources of hese accessory food factors such as meat, milk and ggs.

It may be of interest to mention here that the firm which has been chosen to produce the concentrate in amaica by the method finally adopted at Teddington estimates that the product can be marketed at bout 6*d*. per lb. Seeing that a daily intake of ½ oz. of the product per person is contemplated, this figure should be low enough for the material to be within the reach of the poorest inhabitants.

One of the means by which this low cost has been secured has been to couple production with the working of a cane-sugar mill and thus to make use of available surplus quantities of molasses and of steam.

The type of micro-organism which for the time being has been chosen for the production of the concentrate is similar to that used in Germany and known under the name of *Torula utilis*. It was necessary, however, to develop from this organism a new strain which would grow well at temperatures higher than those tolerated by the standard strain, since the maintenance of the lower temperatures in tropical countries would have involved the adoption during manufacture of expensive cooling operations. It was desirable also to increase the size of the standard strain with the view of facilitating the separation of its cells from the medium in which they had been grown. Both these requirements have been met in the polyploid strain described under the provisional name of *Torulopsis utilis* var. *thermophila*. Another development in technique evolved at Teddington has contributed towards a reduction in manufacturing costs. In the usual methods of yeast production a five- to six-fold increase is anticipated in the weight of yeast introduced as inoculant into the nitrogen-carbohydrate solution in which the yeast is to be propagated during the usual nine-hour growth period. By the method worked out at Teddington this yield has been raised to a minimum of a fifteen-fold increase, thus making it possible to secure a greatly increased output of protein and vitamin from a given plant capacity or, alternatively, to produce a given output of concentrate in a smaller plant than would normally be needed.

Future work may show that another type of micro-organism may be preferable to *Torulopsis utilis* var. *thermophila*.

The yield of dry yeast, with five per cent of moisture, which is secured in the pilot plant working at Teddington, amounts to 30 per cent on the molasses used, assuming this to contain 50 per cent of sugar, or 60 per cent of dry yeast concentrate on the sugar used during the synthesis. The yield of crude protein in the yeast, as calculated on the inorganic nitrogen supplied during the growth period, represents an almost theoretical conversion.

When the period of growth has been completed the yeast produced is carefully washed with water in yeast separators, and the issuing yeast suspension passed over drying rollers, whence it issues as the final protein-vitamin concentrate. In this form it consists of light, straw-coloured thin flakes which have a pleasant nutty or meaty taste. It is now known under the name of "Food Yeast".

Besides the high protein content, which amounts to between 45 and 50 per cent, according to the methods of estimation, food yeast represents a potent source of B vitamins of which it contains the whole known range, including aneurin to the extent of 20 μgm. per gm.; riboflavin in absorbable amounts of 80–85 μgm. per gm.; and nicotinic acid 400–450 μgm. per gm.

It is readily miscible with water, soups, milk and stews. It can be incorporated into flour and thus baked to a loaf to which it imparts its slightly nutty or meaty flavour. Some very successful attempts have been made by the laboratories of the Co-operative Wholesale Society to produce a palatable loaf and biscuits from flour incorporated with food yeast.

During the period covered by the investigations at Teddington it has been possible to supply food yeast to a number of workers who have been interested in determining its nutritive value. Reference has already been made to Macrae's work, which proved its value in pig feeding. Chick[8] found that food yeast added to white flour (73 per cent extraction) increased the value of such flour in rat feeding and made it equal in this respect to wholemeal flour.

Kay[9] at the National Institute for Research in Dairying reports that food yeast is an excellent and palatable high-protein food for pigs and young dairy stock and almost certainly for dairy cows in milk. It produces no intestinal or other disturbances.

In human nutrition, Stephenson, Penton and Korenchevsky[10] record preliminary observations on the value of food yeast when given to aged people with added ascorbic acid. These observers state that in suitable cases improvement in, or disappearance of, some pathological senile features was noticed.

Other workers have tried the value of food yeast in child nutrition; in cases of typical B vitamin deficiencies; in the treatment of jaundice and of certain forms of anæmia. Published reports on these tests are not yet available, but the general conclusion has been that the effect of the addition of food yeast to the patient's diet has been beneficial.

If it may be claimed, therefore, that the microbial protein and the B vitamin concentrate, food yeast, can supplement a restricted diet lacking in animal proteins and their accessory food factors, it is to be expected that the peoples of devastated countries in Europe and the Far East would benefit from its incorporation into their diet. For it is safe to predict that meat and other animal proteins will be in extremely short supply in devastated countries during the immediate post-war period. In fact, there is reason to expect that several years will lapse, after peace conditions have been re-established, before the destroyed herds of cattle of war-ravaged countries can be replaced and the agricultural output of meat and milk be increased to pre-war figures.

The quantities of food yeast which would be needed for incoporation into the restricted diet of Europe after the War could be rapidly provided, and often within the countries themselves, for food yeast production possesses an important advantage over meat production in that it can be completed in hours while meat production may take months or years. It would be essential, of course, to have a source of carbohydrate available, but in most devastated countries it should be possible within a single season to set aside a certain amount of carbohydrate for the purpose, either in the form of potatoes or of sugar beet. As for the inorganic nitrogen source required, this should be readily procurable during the post-war period. In this connexion it is worth recording that one acre under a carbohydrate crop could yield 840 lb. of protein in the form of food yeast but only some 70 lb. in the form of meat or milk protein, while the vitamin B output from the food yeast would be even more than proportionally higher. It is worth mentioning also that, at existing prices, beef or mutton proteins would be five time as dear as food yeast protein, milk protein eight times and egg protein twenty-four times as dear. The B vitamins of beef, mutton or milk would be twenty-five times and of eggs eighty times deare than those of food yeast.

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[1] Klöcker, "Die Gärungsorganismen", first edition, Max Waag Stuttgart (1906).

[2] Märker, "Handbuch der Spiritusfabrikation", second edition, p. 48 (1877).

[3] Delbrück, Hayduck and Wustenfeld, "Jahrbuch des Vereins de Spiritus Fabrikantem in Deutschland", p. 25 (1910).

[4] Hayduck, *Z. Spiritusindustrie*, **38**, 161 (1915).

[5] Völtz, *Z. Spiritusindustrie*, **38**, 235 (1915).

[6] Osborne and Mendel, *J. Biol. Chem.*, **38**, 223 (1919).

[7] Macrea, El-Sadr and Sellers, *Biochem J.*, **36**, 460 (1942).

[8] Chick, unpublished data (1941).

[9] Kay, unpublished report (1940).

[10] Stephenson, Penton and Korenchevsky, *Brit. Med. J.*, ii, 839 (1941)

DEVELOPMENT OF BIOLOGICAL SCIENCE IN RUSSIA

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THE history of the development of the natura sciences in Russia is closely connected with thei powerful development in Western Europe and i North America. Indeed, during the initial period c the establishment of the exact sciences in ou country, a number of distinguished European scientific men were invited to Russia where, living an working for long periods, they contributed many nev pages to world science. Names of members of th Russian Academy of Sciences, such as Karl Erns von Baer, Pallas, Bernoulli, Euler and others, ar well known. Beginning with Michael Lomonosov many Russian men of science worked and studie in famous laboratories of Great Britain, France an Germany. But it would be wrong to look upon th history of the development of the natural sciences i Russia—as historians of science often do—as only result of the activities of those great men of scienc from Western Europe who came to Russia and pursued their work in the young Russian Academy o Sciences.

Special importance in the history of the development of the exact sciences is attached to the nineteenth century, "the century of natural sciences" a K. A. Timiryazev has repeatedly called it. The mai edifice of the natural science of the nineteent century was constructed in friendly internationa collaboration by the scientific workers of the Ol and New World, and in this work Russian men c science were the originators of a number of importan and independent branches of natural science.

The beginnings of an independent science in Russi emerged in the second quarter of the nineteent century in an atmosphere of exceptionally intens intellectual activity, and were the result of th great social movement in Russia of the 'fiftie and 'sixties which laid the foundation for the emancipation of the peoples of Russia from reaction i all its manifestations. It came into being as a resul of the independent critical advancement of the bes achievements of human culture. By the end of th 'fifties, inspired by the philosophical and scientifi works of his remarkable compatriots, B. G. Belinsk and A. I. Herzen, N. G. Chernishevsky wrote: "I their conceptions these people no longer depende on foreign authorities", and that "Here, for the first time, the intellectual life of our fatherland created men who marched abreast of the thinkers of Europe and not, as had been the case previously, in the ranks of their disciples".

These words, a reflection of "national pride" (Chernishevsky's words), were expressed in the years when there began to appear the first galaxy of Russian men of science, who brought so much glory not only to the Russian people but also to all mankind. The names of Sechenov, Mendeleev, the brothers Kovalevsky, Mechnikov, Pirogov, Butlerov, and, later, Pavlov, Timiryazev and Michurin, speak for themselves.

Long before this period, in the eighteenth century, the work of Michael Lomonosov, son of a Pomor peasant, in physics, chemistry, mathematics and literature entitled him to a place beside the founders of modern exact science—Copernicus, Newton, Lavoisier. As it is now known, Lomonosov, with the vision of a genius, foresaw and created the foundations of a number of new branches of the natural sciences. Unlike his predecessors—the brilliant Western European naturalists and philosophers of the seventeenth century—he not only stood at the peak of knowledge of his own times but also mapped the course of development of the following century. In an address in 1924 on the role of Russian chemistry in world science, Prof. W. P. Wynne, then president of the Chemical Society of London, stressed the fact that even before Lavoisier, Lomonosov had formulated the principles of the chemical theory of combustion and respiration. In fact, the works of Lomonosov have actually provided the impetus for the development of such young branches of natural science as physical chemistry and chemico-physics.

Appearing at the beginning of the nineteenth century, the brilliant mathematical works of Lobachevsky have for many decades and right up to our own days impregnated world mathematical thought. Clifford has vividly described the importance of his work. He declared: "What Vesalius was to Galen, Copernicus to Ptolomeus, Lobachevsky was to Euclid".

By the 'fifties of the nineteenth century the fame of the Russian organic chemists (Zinin, Butlerov and their disciples) had spread across Europe. Their achievements in the synthesis of organic compounds brought into existence a whole line of followers. A number of investigations were carried out by the German chemist, Hofmann, to repeat, confirm and interpret the achievements of the famous Russian organic chemists who worked in the modest laboratory of the University of Kazan, where Lobachevsky was carrying out his scientific exploits. The principles of the artificial synthesis of pigments worked out by Russian chemists re-equipped the technological processes of certain branches of European industry, of German industry in the first place. Certain German chemists have in the past tried to dispute the discovery of the periodic system of elements by the immortal Russian chemist, D. I. Mendeleev. But these attempts were and will be in vain; Mendeleev's work is the basis of modern chemical conceptions.

It is not possible here to discuss the significance of the works of Russian men of science in the development of physics and also of electro-technics. The names of Petrov, Yablochkin, Ladygin, Popov, and finally the brilliant physicist, Lebedev, are associated with the hypotheses and technique of modern physics; to this important section of the history of Russian thought, specialists must give serious attention.

At the beginning of the 'sixties the famous Russian biologists on whose activities we can dwell here in more detail joined the ranks of the great naturalists of the nineteenth century. First of all, it is necessary to emphasize the role of the Kovalevsky brothers, Alexander and Vladimir. Alexander Kovalevsky showed for the first time that there exist organisms which represent a transitional form between invertebrates and vertebrates. These were the ascidians, which he studied in detail. The German scientific worker, Kupfer, repeated the experiments of Kovalevsky, whose findings and conclusions he confirmed.

At a meeting of the Royal Society of London, a report was given on Kovalevsky's discovery which, as was stated by T. H. Huxley, then president of the Society, created a great impression. Carefully studying Kovalevsky's works, Charles Darwin wrote to Kovalevsky's brother, Vladimir: "Few men will have made such fine discoveries as your brother". It is possible to say without exaggeration that one of the most authentic and convincing proofs of Darwin's evolutionary theory is the group of facts discovered by A. Kovalevsky, one of the world's greatest embryologists, which have been confirmed and recognized by his numerous followers in Europe and America.

In the conversation that took place when K. A. Timiryazev visited Charles Darwin in his house at Downe, in 1877, the latter spoke with particular esteem of the works of the Kovalevsky brothers, especially those of Vladimir. V. Kovalevsky is acknowledged by world science as the founder of evolutionary palæontology. Having explored the vast material on fossil vertebrates, V. Kovalevsky mapped entirely new paths in the field of palæontology and, indeed, laid the foundations of historical palæontology. After visiting a number of European geological and palæontological laboratories, he justly complained of the fact that though many European investigators of his own time were working on important fossil organisms, their work remained a mere description of forms "without any conclusions". This latter impression V. Kovalevsky confided to his brother in a letter referring to German workers in particular. In spite of the fact that V. Kovalevsky actually had no chair and no laboratory and was compelled, because of material difficulties, to do work unconnected with science, the greatest palæontologists of Europe and America are proud to consider themselves his disciples. In his review of the history of palæontology, Henry Fairfield Osborn stated that the works of V. Kovalevsky opened "a new era in palæontology . . . [they] swept away all the dry traditional European science of fossils".

With a feeling of deep national pride we must note the fact that among the founders of modern medicine, world science has given to Ilya Mechnikov an honourable place alongside the Frenchman, Pasteur, the Briton, Lister, and the German, Koch. If, with burning conviction, Pasteur and his followers proved that the leading part in the inception and development of diseases in human beings, animals and plants is played by the infection of these organisms with disease-bearing bacteria, to Mechnikov belongs the honour of revealing the main ways in which the struggle goes on between the organisms and the microbes. The Mechnikov theory of phagocytes, so brilliantly argued with much comparative pathological data, actually laid the foundation for modern teaching on the process of immunization of organisms to diseases and on the means by which the organisms fight the diseases.

One of the greatest achievements in the field of medicine is the discovery of filtrable viruses. Not very long ago, in 1938, in a résumé devoted to this problem, Anton Dohrn tried to prove that the discovery of filtrable viruses belonged not to the Russian scientist D. O. Ivanovsky but to German investigators. But facts are stubborn things; it was Ivanovsky who, on February 12, 1892, in his report to the Russian Academy of Sciences, for the first time presented data which laid the basis for modern teaching on filtrable viruses. The whole of world science, including the best modern experts on this question, headed by the American, Stanley, who in 1935 discovered the crystalline nature of filtrable viruses, recognizes Ivanovsky as the "father of virus research".

An honourable place among the founders of modern medicine is rightly occupied by N. I. Pirogov, the Russian surgeon, a pioneer of field surgery. A number of classical operations originated by him have not, even at the present time, been excelled in their daring and brilliant simplicity. He methodically worked out the foundations of modern topographical anatomy. Finally, to Pirogov and his disciples belongs the idea and realization of the new method of anæsthesia, the so-called non-inhalational narcosis which, known as the "Russian method", has been widely adopted.

When the young Russian physician, Ivan Sechenov, whose mother was a Kalmuk peasant, first appeared in Western Europe in 1857–58, he soon attracted the attention of noted European scientific workers. Already in his first published work this twenty-seven-year-old physiologist discovered and made known the experimental mistake of the celebrated physiologist of the nineteenth century, Claude Bernard. In the very same year the great German physiologist, Helmholtz, wrote that in his laboratory Sechenov had made an important discovery about crystalline fluorization and that in this sphere the work of the Frenchman Renault lagged behind the work of Sechenov in every respect.

Starting work in the laboratory of the brilliant master of physiological experiment, Karl Ludwig, Sechenov realized the inadequacy there of experimental methods for studying the gases of the blood, and he embarked on independent work in this difficult field. Sechenov constructed a special apparatus for the study of gases of the blood which he called the "absorbtometer". Ludwig ordered Sechenov's apparatus for his own laboratory. Experimenters like Helmholtz, Pflüger, Bohr, and, later, Warburg and Barcroft, introduced a number of modifications to the basic model created by Sechenov. Widely used in all modern physiological and biochemical laboratories of the world, appliances for studying gases of the blood and also respiration of the tissues are, despite many small modifications, only variations of Sechenov's model.

In his discoveries of the phenomena of central torpor in the highest sections of the nervous system of animals and man, Sechenov's work has received world recognition. Up to now physiologists of all countries have continued to work on the interpretation of the phenomena discovered by Sechenov. Long before many of the greatest physiologists of modern times, especially the famous British physiologist, Sherrington, and the German physiologist, Hofmann, Sechenov discovered and described in great detail the complicated phenomenon known as muscular sensation. He noted for the first time that the muscular system of animals and man is at the same time the system of the organs of sensation, which fact had great importance in the co-ordination of movements of these organisms. The most complicated physiological laws which underlie the latest conclusions on the mechanism of the co-ordination of movements (particularly the question of so-called antagonistic excitation of the muscles) were originally described in Sechenov's works. First to direct attention to all these facts was Prof. A. F. Samoilov, famous for his work on the physiology of the nervous system.

It is difficult to over-estimate, and even still more difficult to deny, the all-important part played by Sechenov in the discovery of a completely new approach in the physiology of the nervous system, which made possible the objective study of such complicated phenomena as the conduct of animals and human consciousness. This indisputably Russian trend in world physiology was brilliantly developed by Sechenov's closest follower—the scientific genius, I. P. Pavlov.

Among the direct disciples of M. Sechenov we must note the name of one of the greatest Russian physiologists, N. E. Vedensky, who developed Sechenov's work and discovered a number of new laws relating to the most complex questions of the activity of the nervous system. It is possible to say without exaggeration that contemporary physiology of the nervous system is nourished to a great extent by ideas and experimental data belonging to Vedensky or connected with his name. It is well known how much attention British and American schools of physiology have devoted to the elaboration of Vedensky's scientific heritage on the most delicate processes of excitation and torpor of nerve cells and nerve fibres. At the International Congress of Physiologists in 1935, Prof. Louis Lapic, of the Sorbonne, admitted that his own teachings on chronaxie were without any doubt formulated in other terms by Vedensky long before him.

It is unnecessary to speak of the fame of Pavlov and his school. He has been well appraised by the American physiologist Prof. W. B. Cannon: "if they do not know about him they think according to Pavlov's ideas, and if they do not think according to his ideas, their digestion works along those lines".

At the end of the nineteenth century, when Pavlov's book "Lectures on the Work of the Digestive Glands" appeared, the celebrated German physiologist, Funk, observed: "it is difficult to find a scientist who in so short a time has been able to make so many discoveries". Meeting in the U.S.S.R. in 1935, the International Congress of Physiologists unanimously recognized Pavlov as "leader of the physiologists of the whole world". The works of Sechenov, Pavlov, Vedensky and their disciples have won a prominent position for the Russian school of physiology.

The end of the nineteenth century was marked by discoveries by Russian scientific workers which illuminated the most important processes of organic matter—the processes of the synthesis and decomposition of organic matter, and the changes of matter in Nature. On the basis of brilliant and careful experiments, K. A. Timiryazev established new conceptions of the role of chlorophyll and the energy of light in the synthesis of organic matter from carbon dioxide and water. The work of S. Vinogradsky led to the understanding of another most important branch of the synthesis of organic matter in Nature, namely, the 'fixation' of nitrogen of the air by the synthesis of complex organic nitrogen compounds. Vinogradsky's discovery of the relation of atmospheric nitrogen to soil bacteria represents a new epoch in biology and agriculture.

From different aspects, the work of V. Paladin and A. Bach led to an understanding of the biochemical processes forming the basis of the respiration of plants and animal cells.

From its inception the evolutionary teaching of Charles Darwin had ardent protagonists in Russia among philosophers and scientific men such as Pisaryev, Timiryazev, Mechnikov, and, later, Mensbir and A. N. Severtsov. At the very beginning of the twentieth century, simultaneously with Sedgwick, A. N. Severtsov widened and deepened Darwin's teachings by his work on the study of the relationship between the individual and the evolutionary development of organisms.

All these achievements of Russian biologists during the nineteenth century form the basis for the many-sided development of science in Russia which has characterized recent years. Scientific men of the U.S.S.R., fully aware of their debt to their people, always remember the words of one of their teachers, I. P. Pavlov, who said: "Our fatherland opens vast fields to scientists, and it is necessary to repay the debt; science is generously introduced into the life of our country—to the last degree, generously . . . and for us it is a matter of honour—to fulfil the great hopes that our country places on science".

ASPECTS OF INDIAN INDUSTRIAL DEVELOPMENT

PRIOR to the War of 1914–18, Indian industrial development, except for the textile industries based on cotton and jute, were on a minor scale. The great Tata iron and steel works at Jamshedpur were still in process of erection and it was not until after 1917 that it was in a position to make a major contribution to the war effort. Public opinion had already forced the Government of India to recognize the desirability for a more rapid industrial development, resulting in the appointment of the Indian Industrial Commission. Unfortunately, many of the recommendations made in the Commission's valuable report were not implemented, nor was much attention paid to the suggestions for the development of chemical and metallurgical industries made in the pamphlets issued by the Indian Munitions Board. The temporary impetus resulting from the War soon died down and almost the only large-scale industry based on science which developed during the next two decades was that of soap and related products, manufactured by modern methods, in the Tata Oil Mills. It would serve little purpose, nor would it indeed be profitable, to discuss the varied causes for this, but one of the main causes has undoubtedly been lack of adequate technical advice and of skilled labour.

Now, with another war of world-wide range, the opportunity has once more arrived for India to become industrialized, and this time we feel there can be no relapse. As a supply centre for the Near and Far East she occupies a key position. This time it is possible for the advance to be planned and to be based upon solid scientific research. It is true that for many years now, cotton, jute and lac have had their research organizations, and therein lies probably the cause of their prosperity, but planned industrial research on the many problems of the chemical and metallurgical industries under tropical conditions has been almost completely lacking. This gap has now been filled by the new Board of Scientific and Industrial Research. A further guarantee that the fundamental chemical industries will be established on an adequate scale is furnished by the decision of Imperial Chemical Industries, Ltd., to form an Indian company. We may anticipate that this will meet with success equal to that achieved by the similar organizations in South Africa and Australia.

Rich as India is both in mineral and plant products, she is, like other countries, by no means fully self-sufficient. The main coal deposits are situated far from the Punjab, Bombay and Madras, although this lack of fuel is to some extent compensated by cheap electricity generated by water-power. A further fundamental requirement is sulphur for the manufacture of sulphuric acid, since even now it is true that the consumption of sulphuric acid provides an index of a country's industrial development. India drew her supplies of sulphur almost entirely from enemy countries, Italy and Japan, and although the immediate war-time needs are being met from the comparatively small deposits in Baluchistan, these, besides being difficult of access, would be quite inadequate in normal times. A nearby and practically inexhaustible source of supply could be made available by the desulphurization of the waste gases from the Anglo-Iranian oil-fields. In an interesting paper, Forrester and Gilbert (*Trans. Min., Geol. and Metal. Inst. India*, 37, 61–168; 1941) have surveyed some aspects of chemical and metallurgical industries as applied to Indian conditions, and they suggest that considerable quantities of sulphur dioxide could be recovered from the Indian Copper Corporation's smelting plant. This source, were it developed, would, however, only very partially meet India's normal requirements, and other sources will have to be found. The former possibility would appear to be worthy of careful consideration, since it would at the same time give a gas suitable for the manufacture of a high-class carbon black.

Whereas the metallurgical industries based on iron are already developed on a large scale in India, no attempt has been made so far to establish the manufacture of either aluminium or magnesium, although much has been written on the subject. For the manufacture of the former, both the necessary raw materials and cheap electrical power are available, so that presumably lack of capital and of adequate scientific assistance have caused the delay in the establishment of this essential industry. The growing importance of the lighter alloys would justify also the manufacture of magnesium, for which the separation of magnesium salts from sea water by modern methods would provide the necessary material.

In their paper, referred to above, Forrester and Gilbert tabulate a long list of coal-tar products which are now being made in India; but with the relatively small and scattered gas plants which are in operation, it would appear doubtful if a large-scale industry—and to be economically successful it must be on a large scale—can be developed from coal-tar. It would seem that in India a synthetic chemical industry must be based on different materials, and for such new developments she is not ill-situated. There are in Assam and in the Punjab developed sources of petroleum, and even if these fields are relatively small as compared to those of Russia and America, they should provide sufficient materials for the manufacture of chemicals which recent research has shown to be readily obtainable from the oil and gas. It seems likely also that the manufacture of calcium carbide will soon be undertaken, and if this were done, acetylene would be available, from which, as has been found in Canada, a host of subsidiary chemical industries can be developed. Finally, thanks to the research work initiated by Barber at Coimbatore and since extended by many other workers, cane sugar is now produced on a very large scale. By well-established processes, sugar provides a source of a great variety of products such as alcohol, acetone, butanol, citric and gluconic acids.

In India, a chemical industry based upon petroleum, sugar and calcium carbide might prove to be far more economical than one based upon coal tar. Development on these lines will necessarily involve much fundamental research and may appear to be speculative at the present time, but it seems to be more likely to lead to success than one based on older and well-established methods. It would certainly be profitable for the younger chemists now being trained in India to devote some of their energy and skill to a consideration of these problems. A further large field for research is to be found in the development of India's reserves of cellulose. In Sweden the exigencies of war have emphasized how very valuable a raw material this is. In the post-war years, we may anticipate that India will lead in this and in other fields of technical research.

PIONEERS OF REFRIGERATION*

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

During the greater part of the nineteenth century, there was a considerable trade in natural ice, and ice cut from Wenham Lake, near Boston, in the United States, was known in many parts of the world. Some of this ice came to Great Britain, which also obtained supplies from Greenland and Norway. It was this trade which led the famous engineer, Richard Trevithick, in 1828 to suggest to his friend, Davies Gilbert, that ice could be made by the compression and expansion of air.

The earliest apparatus for making artificial ice was that of William Cullen, who described his water evaporating device so long ago as 1755, while he still held the chair of chemistry at Glasgow. He was the first of many Scotsmen to further the practice of artificial cooling, and about half a century after he had made his evaporation apparatus, John Leslie, while holding the chair of mathematics at Edinburgh in 1810, devised his water absorption apparatus, in which water evaporated in a vacuum was absorbed by sulphuric acid. Writing in the seventh edition of the "Encyclopædia Britannica", Leslie referred to his method of "producing congelation on a large scale" and added that with a proper system of air-pumps, worked by a steam engine of six horse-power, it might be possible in the climate of London to produce ice at the rate of a ton a day. The need for means of cooling was felt most in breweries, and the patents taken out for cooling worts and other liquids are very numerous. The first of such patents is that taken out in 1819 by Robert Salmon, the ingenious mechanist to the Duke of Bedford, at Woburn Abbey, in conjunction with William Warrell. This patent was No. 4331 of January 15, 1819.

As is well known, the three principal types of refrigerating plant which have been used on a large scale are the ammonia absorption machine; the air refrigerating machine, first visualized in a crude manner by Trevithick; and the vapour compression machine, the first example of which was made in an East London engineering shop for the American engineer, Jacob Perkins (1766–1849), according to his patent No. 6662 of August 14, 1834. Though a trial was made with the Perkins machine, it was not very successful and the inventor, having many other things on hand, did not pursue the matter.

About ten years later, the idea of using machines for cooling air in sick-rooms, hospitals, etc., occurred almost simultaneously to the American physician, James Gorrie (1803–55), of Apalachicola, Florida, and to the Astronomer Royal for Scotland, Charles Piazzi Smyth (1819–1900). Both these men spent about ten years trying to develop their ideas, and on May 6, 1851, Gorrie secured the United States patent No. 8080, the first patent for an air refrigerating machine. Smyth in his work had the assistance of Rankine, and of James Stirling, the brother of the Rev. Robert Stirling, who had invented the hot-air engine. Though Smyth's proposals were the subject of a report to the Indian Government, nothing came of them. Gorrie, on the other hand, did apparently see some of his plans adopted, but when he tried to get them introduced on a larger scale, his funds failed, his health broke down and he died at the early age of fifty-two. His merits, however, have not been forgotten and his statue now stands in the Statuary Hall, Washington, D.C.

By the time of Gorrie's death, artificial cooling had become a matter of great interest in Australia, where some far-sighted individuals saw that the surplus meat of the Colonies would readily find a market in Europe if means existed of preserving and transporting it. Among those whom this question stimulated was the Scottish journalist, James Harrison (1816–93), and the Lancashire wool broker and business man, Thomas Sutcliffe Mort (1816–78), both of whom had emigrated to Australia about 1838. Harrison had a long career as a journalist and at one time edited the *Melbourne Age*. He was also the parliamentary representative for Geelong, Victoria, where he had settled. It is said that he corresponded with Faraday and Tyndall, but however this may be, in the 'fifties he began experimenting on ice-making, and in 1855 took out an Australian patent; then coming to England, he secured patents No. 747 of March 28, 1856, and No. 2362 of September 10, 1857, for a vapour compression machine using ether. His earliest machines were made in Holborn by the German engineers, Siebe Brothers, the founders of the well-known firm, Siebe, Gorman and Co., Ltd., the first machine being set up at the famous paraffin works of James Young at Bathgate, Scotland, the cradle of the Scottish shale oil industry. Previously, to separate the solid paraffin from the oil, it had been necessary to store the oil in summer and then expose it in flat dishes in winter. Another Harrison machine was set up at the brewery of Truman, Hanbury and Co., Ltd., London, and a third was taken back by Harrison to Australia, where his machines were afterwards made in the works of P. N. Russell and Co., of Sydney.

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* Substance of a paper read before the Newcomen Society on March 10.

The introduction of the Harrison machine had two unexpected results: it led to the Siebe firm becoming makers of refrigerating plant, and to the invention by Alexander Carnegie Kirk (1830–92), the engineer of the Bathgate paraffin works, of the closed-cycle air refrigerator which he described very fully to the Institution of Civil Engineers in January 1874, when one of his machines had been running successfully for ten years. Kirk had had a good scientific and practical training, and afterwards became widely known as one of the chief pioneers of the marine triple expansion engine. His refrigerating machine was introduced because the use of ether had been found dangerous and the Harrison machine too small. In his inquiries, Kirk learnt about Gorrie's machine and also studied the Stirling hot-air engine.

Meanwhile, there had been progress in other directions. In 1860, Ferdinand Carré patented the ammonia absorption machine; in 1861, Mort at Sydney founded the first freezing works in the world; in 1864, Charles Tellier (1827–1913), the French pioneer of cold storage and of marine refrigeration, took out his first British patent; in 1867 the American inventor, Thaddeus S. C. Lowe (1832–1913), was granted provisional protection for a patent which included the use of liquified carbonic acid, and in 1869 Franz Windhausen, of Brunswick, secured a British patent, the first of several, for a cold-air machine. To this period also belong some of the patents of Mort, who had the assistance of the French engineer, E. D. Nicolle, manager of P. N. Russell and Co. Applications for patents in connexion with cooling were reaching the British Patent Office at this time at the rate of about one a week.

The next decade, 1870–80, was perhaps the most fruitful, as it is certainly the most interesting period in refrigeration history. It saw the initial work at Munich of Carl von Linde, the introduction of his ammonia compression machine and the founding at Wiesbaden of the Gesellschaft für Linde Eismachinen; the invention in France by Paul Giffard of an air machine which was taken up and improved in England; the introduction by Raoul Pictet, of Switzerland, of the use of sulphur dioxide as a refrigerant; the building by Tellier of a cold store at Auteuil and the fitting out by him of *Le Frigorifique*, the steamer which in 1876 brought a consignment of meat from the Argentine to France; the collaboration of the Bells with Coleman, which resulted in the voyage of the first refrigerator ship on the North Atlantic and the voyage of the first refrigerator ship to carry meat to England from Australia; and also the early work of Alfred Seale Haslam (1844–1927) of Derby, of Thomas Bell Lightfoot (1849–1921), the founder of the Lightfoot Refrigerator Co., and of Everard Hesketh (1854–1942), for fifty years the inspiring head of H. and E. Hall, Ltd., of Dartford. Hesketh, who died at Johannesburg last year, was the last of this band of pioneers.

Of outstanding importance was the work of Joseph James Coleman (1838–88), with whom the Bells formed the Bell-Coleman Mechanical Refrigeration Co., of Glasgow. Henry Bell, born in 1848, and James Bell, born in 1850, were the sons of John Bell, a successful Glasgow butcher, whose business they carried on and extended, possessing in the end more than three hundred shops, which passed into the hands of Eastman, of New York. In the middle 'seventies, a certain amount of meat was imported from North America in ships fitted with ice chambers. Looking for better means of cooling, the Bells sought the advice of Sir William Thomson (Lord Kelvin), by whom they were placed in touch with Coleman, who curiously enough was research chemist at the Bathgate oil works. Born in Lincolnshire in 1838, Coleman had passed his youth with a pharmacist in Halifax, where he attended the Mechanics' Institute. His progress was such that at the age of twenty-two he contributed a paper to the British Association on atomic weights and atomic volumes. For several years he taught science in Chester Training College, but was led to the study of mineral oil manufacture and was offered the post at Bathgate. While there, in 1874, he patented a machine for compressing and cooling the waste gases from shale oil works, this machine being the precursor of his cold-air refrigerating machine, patented jointly by Coleman and the Bells on March 3, 1877. With the assistance of D. and W. Henderson, shipbuilders and engineers, of the Clyde, experiments with machines, insulation and so forth were carried out, and in 1879 a Bell-Coleman machine was placed on the Anchor liner *Circassia*, in which Coleman made a trip to and from America.

The results of this trip were so successful that the Anchor Line decided to fit up all its thirteen ships in the same manner. The second Bell-Coleman machine, however, was not placed aboard a liner but aboard the cargo boat S.S. *Strathleven*, which had been chartered by Messrs. McIlwraith, McEacharn and Co. to make an experimental trip to Australia and back. Unlike to-day, the meat was taken on board fresh and then frozen. Having received and frozen a consignment of about forty tons, the *Strathleven* left Sydney on November 29, 1879, and Melbourne on December 6, and arrived in London on February 2, 1880, with the meat in good condition. Two years later, the sailing ship *Dunedin*, fitted with a Bell-Coleman machine, brought home the first cargo of frozen meat from New Zealand. By then other engineering firms had begun the construction and installation of air refrigerators, and in the early 'eighties the Bell-Coleman patents were acquired by Haslam. Coleman retired to Bearsden, near Glasgow, where he died at the age of fifty. Both the Bells, on the other hand, lived to a good age, and both were made baronets for their public services.

While von Linde in Germany found the widest scope for his activities in installing ammonia compression plants in breweries, British refrigerating engineers were more concerned with the new frozen meat industry. Cold-air machines continued for many years to be fitted in both cold stores and in ships, but the higher efficiency of ammonia and carbonic acid machines gradually gained them a place in the food industry, ammonia machines being installed in large numbers ashore and carbonic acid machines in ships. There was at first a prejudice against the use of any chemicals afloat, and there was always a question of supplies when ships were abroad. These factors also affected the introduction of refrigerating plant into men-of-war when the cooling of magazines was found necessary. The first mercantile vessel with a carbonic acid machine for carrying meat was the *Highland Chief*, 1890. The first British man-of-war with a carbonic acid magazine-cooling plant was the battleship *Sans Pareil*, 1897.

OBITUARIES

Sir Sidney Gerald Burrard, Bart., K.C.S.I., F.R.S.

Sidney Gerald Burrard was born on August 12, 1860. He was the eldest son of Lieut.-Colonel Sidney Burrard, of the Grenadier Guards, and was born at Yarmouth, Isle of Wight, in the Dower House built by his grandfather, the Rev. Sir George Burrard of Walhampton. His first school was Uppingham, where Thring was headmaster, but later he was transferred to Wellington, chiefly for the sake of the shorter journey from his home. From Wellington he went up for Woolwich and passed in at the head of the list. He was at the R.M.A. until September 6, 1879, when he received his commission in the Royal Engineers. After two years at the School of Military Engineering, Chatham, he sailed for India. In September 1884 he joined the Survey of India and was posted to the Trigonometrical Branch, in which he so greatly distinguished himself.

A brief outline, with a more detailed account of his most notable achievement, must suffice for this short notice :

1884–94 : latitude and longitude observations with some periods at the headquarter office.

1894–96 : redetermination of the longitude of India from Greenwich, via Germany, Russia, Persia and the Persian Gulf.

1896–98 : tidal and levelling operations.

1898, January : in charge of a camp for the reception of astronomers visiting India for the observation of the total eclipse of the sun. The Astronomer Royal (Sir William Christie) and Prof. H. H. Turner of Oxford were the principal guests.

1899 : became Superintendent of the Trigonometrical Survey.

1901 : published the paper entitled "The Attraction of the Himalaya Mountains on the Plumb Line in India".

1904 : elected to the fellowship of the Royal Society.

1906–7 : published, in collaboration with Sir Henry Hayden, "A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet".

1909 : while on furlough attended the general assembly of the International Geodetic Association in London and Cambridge.

1911 : appointed Surveyor-General of India.

1912 : received C.S.I. at the Delhi Durbar.

1913 : awarded the Victoria Medal by the Royal Geographical Society.

1914 : made K.C.S.I.

1915 : tenure of the office of Surveyor-General extended for the duration of the War.

1919 : Retired from the Service.

After retirement Sir Sidney bought a house at Farnborough and settled there.

In 1933 he inherited the baronetcy of Walhampton from his cousin and became seventh baronet.

All Burrard's work during his long career was excellent, but his great contribution to knowledge was contained in the paper published in 1901 entitled "The Attraction of the Himalaya Mountains on the Plumb Line in India". To make the nature of this contribution clear, it will be necessary to explain the state of opinion on the subject of mountain attraction which prevailed before this paper was published. One must go back to the observations of Everest and Waugh and the calculations of Pratt. The discrepancy between the observed attractions and the results of Pratt's calculations showed that the apparent added mass of the mountains must somehow be balanced by a deficiency of mass in the crust underneath them. This led to the theory of mountain compensation. It was shown by observation that the deflexion of the plumb line towards the mountains was quite large at places close to them, but that it petered out rapidly and quite disappeared at a moderate distance from them. If then the effect of the great Himalayan ranges does not extend far, it follows that all deflexions found at more remote stations of observation must be due to local causes, visible or subterranean, and that they would therefore resemble random errors unconnected with any structural principle, and ought to be dealt with in further determinations of the figure of the earth by taking the average of a large number of observations evenly spread over a large area. To secure an adequate number of such observations had been the aim of the programmes of latitude determinations which had been systematically carried out, and by the end of the last century a considerable number of results was available. Burrard soon noticed that the arrangement of the deflexions was not random at all, and he then proceeded to study the whole question.

The outcome of this study was the paper mentioned above, in which three major conclusions are arrived at :

(1) The distribution of deflexions of the plumb line is not random but systematic. The deflexions are arranged in zones and these zones are parallel to the curve of the Himalaya Mountains.

(2) No arrangement of mountains and their compensation, whether the latter be situated near the surface or at a great depth, is capable of producing large deflexions at places close to the mountains and small deflexions at places moderately distant from them.

(3) It follows that to account for the observed facts a second cause is required, and a hidden range of high density running across India, parallel to the Himalayas, and with its crest some 400 miles from the foot of the mountains, would be a possible explanation.

The immense importance of these conclusions, especially of the first, is easily seen. Whereas hitherto deflexions of the plumb line had seemed to be unconnected with the tectonics of the earth's crust and therefore of little interest, it was now shown that they were closely bound up with mountains and mountain compensation, and would repay intensive and systematic study. This discovery had a profound effect on all geodetic thought, and from the time of its publication the study of the nature and extent of mountain compensation by means of the observation of gravity anomalies, whether in direction or intensity, has become a major field of scientific inquiry.

Space does not permit of further description of Burrard's attainments or of his personality and character, but as one who had been his colleague for thirty years, intimately acquainted with all that he thought or did, and who continued for twenty more years to be on terms of the closest friendship with him, I may say that there never was a man more delightful to work with, and that he never gave his mind to any subject, music, art, history or science, without throwing some new light upon it. His conversation was the most refreshing and stimulating that I have ever known, and his death leaves a blank that cannot be filled.

G. P. Lenox-Conyngham.

Prof. F. G. Parsons

To many generations of men who received their medical training at St. Thomas's, the news of the passing of Frederick Gymer Parsons in his eightieth year must come with a sense of personal loss. For Parsons had a personality that could never be forgotten, and into every picture of the Medical School of St. Thomas's there must come, in the memories of hundreds of medical men, a kidney-shaped table and, standing in its concavity, a powerfully-built man with an enormous red moustache. The students sitting round the convexity of the table knew him as a teacher; but many knew him as more than that, for there was no form of student activity he did not foster, no work for student enterprises or welfare he ever found too arduous or ever left undone.

Of those who still cherish such happy memories of Parsons the majority are now in middle life, for his retirement from active teaching took place many years ago. But well past middle life are those who knew him at the height of his activities, when all his great energies were directed towards the subject that he made his own. When Parsons was laying the foundation stone of the work on comparative anatomy by which he must ever be known, London was, from an anatomical point of view, an 'island' of English anatomy entirely surrounded by Scotsmen. In the 'island' were, among others, C. B. Lockwood and G. D. Thane, G. B. Howes and Christopher Addison; and of that group Lord Addison is the only one who remains with us.

These men were making London an anatomical centre equalling in its reputation the traditional glory that clung to Edinburgh. All were what the younger generation of anatomists would now stigmatize as 'old-fashioned', for some were mainly concerned with the Hunterian tradition, some with human topographical anatomy and some, like Parsons, with comparative anatomy. It was mammalian myology to which Parsons devoted most of his energies for research, and this subject and the anatomy of mammalian joints he made his own. He dealt in facts—facts laid bare by his scalpel; and as a storehouse of facts his works are permanent.

It was considerably later that Parsons became especially interested in physical anthropology and made his valuable contributions to our knowledge of the osteology of the earlier inhabitants of England. In all his later work he found much interest in the historical setting of the Saxon Englishman. In this setting he saw even a personal intimacy, for he conceived himself to be representative of the typical Saxon, and probably he was near the truth in this. He loved the sea. He had spent happy years as ship's surgeon. True to the traditions of the sea he loved the countryside, and he had that age-long hankering of the sailor to settle down in retirement in a country inn with roses near the front door.

Parsons lost one great ideal when the tragic death of his wife nearly thirty years ago sundered a perfect partnership. Parsons was a man. He took this great blow like a man. His many friends must rejoice in this, that though he lost his great ideal, he did what many others have failed to do. An active life of devoted and useful work and of scientific attainment passed over into years of happy and contented retirement; and in the end and at the "Swan" in Thame he lived to see one of the dreams of his youth come true.

F. Wood Jones.

We regret to announce the following deaths:

Prof. P. P. Bedson, emeritus professor of chemistry, Durham College of Science, Newcastle-upon-Tyne (now King's College, University of Durham), on April 4, aged ninety.

Sir Edwin Butler, C.M.G., C.I.E., F.R.S., formerly director of the Imperial Mycological Institute, Kew, and secretary to the Agricultural Research Council, on April 4, aged sixty-eight.

Dr. H. Forster Morley, formerly director of the International Catalogue of Scientific Literature and of the Royal Society's Catalogue of Scientific Papers, on April 3, aged eighty-seven.

Mr. R. A. Roberts, a Royal Commissioner for Historical MSS., and formerly senior assistant keeper in the Public Record Office, on April 2, aged ninety-one.

NEWS and VIEWS

Sir Frederick Gowland Hopkins, O.M., F.R.S.

Sir Frederick Gowland Hopkins' published contributions to biochemistry are well known; but as the time approaches of his relinquishing the Sir William Dunn chair of biochemistry at Cambridge, it is perhaps opportune to try to appraise his influence on the progress of the subject from 1899, when he took up work at Cambridge, to the present time. It has frequently been said in Great Britain during these years that "Hopkins *is* biochemistry"; when he decided to make this subject his own, biochemistry, as he visualized it, scarcely existed either in Great Britain or on the Continent. This is not to minimize the monumental achievements of such men as Emil Fischer and Albrecht Kossel, his immediate forbears; but while he fully appreciated the value and significance of this work, Sir Frederick visualized something beyond the isolation and description of the products and components of animal and vegetable tissue. He thought of biochemistry as a tracing out of the chemical events of the living cell, and a relating of these events to function and ultimately to growth itself. All his papers bear the impress of this idea, and to-day it is the accepted meaning of biochemistry. This change-over from the static to the dynamic is largely his work. Not only in his papers, but even more in his lectures and in his discussions over the work of his pupils, this idea was ever uppermost, and if it were possible to measure his influence on the progress of science, his direction of the thought of his pupils and colleagues into these channels would surely be his greatest achievement.

Yet vigorously as Sir Frederick pursued his endeavours to describe the chemical occurrences of the living cell, his point of view was the reverse of vitalistic. Instead of regarding the biochemist as one occupied solely with isolating and analysing, leaving growth and function outside the scope of his investigation, Hopkins had a faith that the chemical changes accompanying and controlling living functions are discernible, and that to devise methods for such studies is the prime duty of the biochemist. It is perhaps scarcely surprising that there grew up around him a school largely devoted to enzyme chemistry in many varied aspects—the machinery of the cell. The extent to which Sir Frederick's view of the scope of biochemistry is now accepted is the measure of his work, but it is only those who have been privileged to study under his influence in the years during which he has directed his school who can appreciate fully what the subject owes to him. His influence on those who worked with him, even for a short time, was always remarkable. He had the precious gift of illuminating discussions. This was especially evident during 'tea club' meetings of the Department, at which papers were read describing work in progress. Sometimes the audience listened to work which appeared dull and even unimportant, but as soon as the Professor opened the discussion the scene changed, the scattered threads made a pattern and the implication of the work took on a new value. In the experience of his pupils this gift is unique. To be associated with Sir Frederick has resulted for many in a certain liberation of the mind which enabled them then and later to approach problems with a new confidence, problems which, but for him, they would have discarded. Many lesser men freeze and inhibit; he thaws and liberates.

The Gas Research Board

DR. JAMES GRIEVE KING, superintendent of the Fuel Research Station, East Greenwich, has been appointed director of the Gas Research Board. Dr. King, who is fifty-one years of age, is a native of Scotland, where he started his career as assistant to Prof. T. Gray at the Royal Technical College, Glasgow, during 1912–1914. During the War of 1914–1918, he was chemist and finally departmental superintendent of Nobel's Explosives Co., Ltd. Dr. King joined the staff of the Fuel Research Station as research chemist in 1919, becoming chief chemist in 1920 and superintendent in 1941. He has a very wide experience in the field of fuel technology. The long list of his published researches includes a number of papers presented, either alone or in collaboration, at autumn research meetings of the Institution of Gas Engineers. His joint paper with the late Eng.-Captain J. F. Shaw, on "Recent Experiments at the Fuel Research Station upon Production of Solid Smokeless Fuel", was awarded the Institution Gold Medal for 1934, and his joint paper with Mr. James Jamieson, on "Products obtained by the Carbonization of Scottish Cannel in Continuous Vertical Retorts", was awarded the H. E. Jones London Medal of the Institution in 1936. Among his earliest publications was a joint paper, with Prof. T. Gray, on "The Assay of Coal for Carbonization Purposes", which described the now classic Gray-King apparatus.

Dr. Frederick James Dent has been appointed joint assistant director of the Board. Dr. Dent is thirty-seven years of age and is a native of Leeds. He obtained the B.Sc. degree in gas engineering at the University of Leeds in 1926, the Ph.D. degree in 1929, and was awarded the D.Sc. degree in 1939. He won the Arthur Smithells Research Scholarship and the Le Blanc Medal in 1927, and was the Institution Gas Research Fellow for 1927–1929. Since 1929 he has been a research chemist of the Institution of Gas Engineers and more recently of the Gas Research Board, engaged upon investigations for the Joint Research Committee. Dr. Dent has also given special lectures on water gas manufacture in the University of Leeds.

Newton's Library

MESSRS. HENRY SOTHERAN, LTD., of Sackville Street, W.1, are offering for sale the hitherto undispersed portion of Newton's library. The collection includes several books of great personal and historical interest in connexion with their former owner, the most important being copies of the first and second editions of the "Principia" and Isaac Barrow's edition of Euclid. According to the vendor's notice of the sale, the first two contain a number of corrections, cancellations and additions in Newton's handwriting. These copies formed the basis of the new editions and, judging from the fact that the title page of the copy of the first edition was revised, it seems possible that this copy was intended for the printer. The edition of Barrow's "Euclidis Elementa" contains MS. notes in Newton's handwriting, mostly giving the propositions in algebraic notation. Books V, VI and X received his special attention. It seems likely that this copy was actually used by Newton in his undergraduate days at Trinity College, Cambridge, when he had come to appreciate Euclid. Other items of interest include a copy of the second English translation of Euclid—that made by Captain Rudd, engineer-in-chief to the Royalist forces, published in 1651. It may be the copy of which Brewster states that Newton "threw it aside as a 'trifling book'". There are also copies of Barrow's "Lectiones Opticæ" (1669) and Huygen's "Traité de la Lumière" (1690), each of which contains an inscription by Newton stating that it was a presentation copy from the author. It is well known that Newton corrected the proofs of the former and made several corrections and additions. It is a surprising and unexplained fact that although Newton by this time was almost certainly in possession of his theory of colours, he did not correct Barrow's ideas on the subject.

The books are offered for sale in two lots, one of them consisting of Barrow's "Euclidis Elementa" and the other of 858 items. It is to be hoped that this interesting collection will be disposed of as a whole and that it will remain in Great Britain. It represents all that is left of the 1,896 books which formed Newton's library when he died in 1727. The complete library was then purchased for £300 by John Huggins, warden of the Fleet Prison, a near neighbour of Newton's. Huggins' receipt for the £300 and a complete list of the books is now in the British Museum. He presented them to his son, who pasted his bookplate, bearing the inscription "Revd. Carol. Huggins, Rector of Chinner, in Com. Oxon.", in all his books. They were afterwards sold for £400 to Dr. James Musgrave, who succeeded Charles Huggins at Chinnor. He pasted his bookplate over that of Charles Huggins, his plate bearing the Musgrave arms and the motto "Philosophemur". The books then disappeared for about 170 years until bundles of them, including one of 200, were sold at rubbish prices at the sale of Thame Park (belonging to the Musgrave family) in 1920. Barrow's Euclid was one of the items disposed of on this occasion. It is these books which are occasionally found in the second-hand bookshops, though many have gone to the United States and, it is feared, many have been treated as waste paper.

The remainder of the library was discovered in 1928 at Barnsley Park (which also belongs to the Musgrave family) by Col. de Villamil, to whose industry and perseverance we owe the unravelling of the mystery of Newton's library. He also discovered at Somerset House a complete inventory of Newton's possessions at the time of his death. This "true and perfect Inventary" is on vellum and is about five inches broad and seventeen feet long. The skins, about thirty inches long, bear, each, a blue sixpenny stamp, and they are all sewn together. From this inventory we learn that Newton "left 362 books in Folio, 477 in Quarto, 1,057 in Octavo, duodecimo and 24 mo., together with above one hundred weight of pamphlets and wast books". The total of volumes was thus 1,896. These were, we read, in six bookcases and were valued at £270. The lot of 858 volumes is offered for £5,000 and the copy of Barrow's Euclid for £500. Further particulars may be obtained from the vendors.

Newton and Alchemy

NEWTON has been regarded by a number of writers as a credulous alchemist. In some notes on Newton's chemical philosophy written upon the occasion of the tercentenary of his birth, Dr. D. McKie (*Phil. Mag.*, 33, 847; 1942) disputes this judgment. Newton's interest in chemistry probably began when he was lodging with Clark, the Grantham apothecary, while attending the King's School. He noted down interesting chemical recipes in his earliest note-books when he had a highly practical mind and great skill with his hands. Later on, in 1665 and in 1669, we have records that he bought chemical apparatus and materials. At this time, too, he experimented on the production of alloys that would take a high polish and would therefore be suitable for use as mirrors in the reflecting telescope that he had recently designed. In considering whether Newton should be regarded as a chemist or as an alchemist, Dr. McKie examines Newton's own chemical writings, from which "it would be difficult to conclude that he was 'a credulous alchemist'. Rather, he appears as a pioneer in the study of chemical attraction, as in fact he appeared to many of those who came immediately after him and who held his 'Queries' in such high regard during the eighteenth century". As distinct from his own chemical writings, Newton copied out many long passages and made very extensive extracts from a large number of alchemical writings. Dr. McKie claims that too much significance has been put upon these extracts. Many of them were from rare books, and many alchemical books gave useful information on the properties of the metals and their compounds. Moreover, Newton copied out passages from books that were not alchemical. "We might also ask what man of science would care to be judged by what he had copied out of books." Newton's chemical thought set forth in his published writings shows an advance towards modern chemistry rather than a reversion to the already discredited pursuit of gold-making.

Historical Method in Teaching Science

PROF. J. KENNER, of the Manchester College of Technology, recently opened a discussion on the "Historical Method in Teaching Science" at a meeting of the Manchester Literary and Philosophical Society. Bearing in mind the need to produce able rather than merely learned men, Prof. Kenner examined the matter, first from the wider point of view of the problem of general education, and quoted from recent articles indicating failures caused by "inadequacy of outlook, a whole method of approach" and by lack of a creative and forward-looking spirit. If those failures are to be avoided in the future, he urged close examination of our educational scheme. If education be defined as deliberate adjustment to environment, he insisted that "if this environment is to be healthy, it must be progressive". Put more fully, his view was that education "should be conceived and designed as a training for life in a progressive environment", and each should contribute to its progress according to his ability. Prof. Kenner recommended that natural science should be taught as a record of progress and of the methods by which that progress has been achieved. Separate courses on the history of science are not necessary. It should be an integral part of teaching. Appreciation of science, its discipline, its procedure and its possibilities are not only useful intrinsically "but also as a criterion of proposed public policy in regard to it". One of the main difficulties in the War, Prof. Kenner pointed out, lies in the present examination requirements.

Reconstruction Problems in School and Home

AN interim report has just been issued by the Electrical Association for Women giving the Association's point of view on post-war reconstruction as affecting education and careers, housing and kitchen planning, and electricity in the home, coupled with the design and performance of electrical apparatus and appliances. So far as education and careers are concerned, it is considered that school buildings must be designed for many age-groups, they should show a high æsthetic standard of design, be of high-grade materials, and pay proper attention to health and comfort. The school should be the centre of juvenile life and a meeting-place for parents and teachers. Greater consideration should be given to domestic subjects both for girls and boys, so that domestic science shall take its rightful place, providing training for new careers in the post-war world and a basis for citizenship. As regards housing and kitchen planning, homes should be designed to meet the varying requirements of different types of occupants—families, single persons, the aged, etc. Public services such as electricity, main water and drainage, and telephones should be universally available.

In the sphere of electrical equipment, it is pointed out that electricity as a source of domestic power is increasingly popular with housewives, who want efficiency and economy. Standardization of voltage, current, apparatus, and accessories such as plugs, sockets, switches, connectors is desired. Table-type cookers and refrigerators should generally be installed in order to avoid stooping. Every newly built home should have its built-in refrigerating unit. Good kitchen lighting is imperative. Women want efficiency instead of 'ornamentation'; they are even prepared to forgo variety if good design and performance is within the reach of all. These are the salient features in the report, collated by Elsie E. Edwards, which is the culmination of two years study by women in all parts of Great Britain.

Livestock Management and Public Health

AT a meeting of the Backs to the Land Club on March 25, the subject of hygiene in connexion with domestic food production was discussed. Prof. J. W. Munro said that scientific men would be willing to tackle any problems that 'backyarders' might be confronted with in the avoidance of public nuisance. Mr. W. McA. Gracie, director of Infestation Control at the Ministry of Food, referred to the problem of rats, and it was agreed that by making knowledge of their movements available, householders could render greater assistance than by isolated and spasmodic attempts at destruction. Pig keepers and poultry keepers contributed to the discussion by giving their experiences of livestock management in built-up areas, and suggested standards that might be laid down to protect public health and amenities after the War. It was agreed that while a measure of livestock keeping is necessary to maintain soil fertility, the disposal of small amounts of manure presents a difficult problem. Some pig clubs have got over the difficulty by composting. The subjects of food storage and insect pests associated with the different classes of livestock were referred to. The chairman, Mr. John Green, said that at law livestock keeping is permitted anywhere provided it does not amount to a nuisance, but that following a number of cases at the end of the last century, many public authorities had passed by-laws under the Public Health Acts, restricting these enterprises.

Phenology of 1942

WITH admirable promptitude in these difficult times, the fifty-second annual phenological report of the Royal Meteorological Society has been issued, covering the observations on the weather and fauna and flora in Britain from December 1941 to November 1942. This is interesting because the cold spring included the coldest February in England and Wales since 1895, and the dry period in summer included a thirty-two days drought, the longest for thirteen years. It was an abundant year for crops and wild and cultivated fruits of almost every kind, while grass fields appeared exceptionally green in the autumn and the season was sufficiently free from frosts to produce a wealth of autumn tints, many oaks keeping their foliage in sheltered places into December. Migrant birds were uniformly late in reaching the most northerly zone in spring, but the cuckoo was the only bird to be late in all three zones, the other zones showing first migrant arrivals in advance of the average dates. 1942 was a year of comparative scarcity of immigrant Lepidoptera, especially of the painted lady butterfly, although some localities had considerable arrivals, and three migrant insects, the red admiral butterfly and the silver Y and convolvulus hawk moths, were recorded in the Shetlands.

Two hundred and sixty-four observers sent in their records, a slight reduction on previous years. It is noted that in order to arrive at a high degree of accuracy in average values for plant and insect dates, there should be revisions at intervals of five or ten years; also that weather responses in different districts must be analysed separately when the meteorological characteristics of the season differ in those districts. Responses depend on the incidence of the weather in relation to the average dates, so that they are not necessarily uniform. The zone diagrams show that there is less difference in date between groups, as a whole, in different zones, than there is between the dates from observing stations in individual groups: the former may amount to a few days but the latter to a few weeks.

Gifts to Universities of Leeds and Sheffield

A FEW weeks ago, it was announced that Mr. Henry Ellison had given the University of Leeds £50,000 to create an endowment fund for the provision of post-graduate fellowships for research in pure and applied chemistry and physics (see NATURE, March 13, p. 303). He has now put the scientific world further in his debt by a gift of £25,000, spread over seven years, to the University of Sheffield, with the suggestion that the money be expended during the years immediately following the War on a scientific research fellowship. Mr. Ellison, who is chairman of the Yorkshire Tar Distillers, Ltd., and has been associated for many years with the Sheffield Chemical Company and the Mirvale Chemical Company, is an old student of the Yorkshire College, the forerunner of the University of Leeds. His gifts, besides being of direct service to the industries in which he is himself directly interested, form a notable addition to the resources available in Great Britain for scientific research.

Co-operative Systems in European Agriculture

THE British Association, through its Division for the Social and International Relations of Science, is arranging a conference on "Co-operative Systems in European Agriculture", to be held on Friday and Saturday, April 16 and 17, at the Royal Institute of International Affairs, Chatham House, St. James's Square, S.W.1, by kind permission of the Institute. The Conference will be opened by Sir Richard Gregory, president of the Association, and there will be four sessions, the subjects of which will be co-operation in three groups of European countries (north, west and east), and immediate relief after the War. Tickets of admission will be obtainable from the British Association, Burlington House, London, W.1.

Announcements

SIR HAROLD HARTLEY has been appointed general treasurer of the British Association as from April 1, the beginning of a new financial year. He succeeds Prof. P. G. H. Boswell, who has resigned after twelve years' service in office, first as a general secretary (1931–35), and then as general treasurer (1935–43). The gratitude due from the Association to Prof. Boswell has been acknowledged in a resolution by the General Committee.

AT the annual general meeting of the Institution of Chemical Engineers, on April 2, the following medals for 1942 were presented: *Osborne Reynolds Medal*, Mr. L. O. Newton; *Moulton Medal*, Mr. W. K. Hutchison and Dr. E. Spivey, for their paper on "Design and Performance of Cooling Towers"; *Junior Moulton Medal and Award*, Dr. S. H. Wade, for his paper on "Evaporation of Liquids in Currents of Air"; *William Macnab Medals*, Mr. J. H. Sharp and Mr. F. J. Wilkins.

THE Committee on Africa, the War and Peace Aims has issued as a supplement to "The Atlantic Charter and Africa from an American Standpoint" a compilation by Rev. Dr. E. W. Smith entitled "Events in African History". This is a chronology in two parts, ancient and modern, with an index mainly of references to persons, places and organizations, with some subject entries. The modern chronology which occupies the greater part of the brochure is in three sections covering, respectively, the period of unrestricted slave-trade, 1415–1807; the period of struggle to extirpate slave-trade and slavery; exploration; partition; preliminary economic development; and expansion of Christianity (1807–1918); and the period of trusteeship (1919–1942).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Development of Cold Agglutinins in Atypical Pneumonia

IN addition to the classical *iso*-agglutinins that delineate the four primary blood groups of man, there exist in many normal sera other substances which may cause clumping of erythrocytes and are called 'cold' agglutinins because in most instances their action appears at low temperatures only. Specific cold agglutinins, concerned with the sub-groups of type *A* blood, have been distinguished[1]. The cold agglutinins are, however, otherwise considered to be non-specific inasmuch as they will produce clumping of all human red blood cells irrespective of group. Moreover, since they likewise affect the cells of the individual in whose serum they appear, they are sometimes named auto-agglutinins. The reaction is delicate and usually disappears when the serum is diluted beyond 1 : 10. Cold agglutinins of this type have attracted attention from time to time when existing in quantity enough to be manifest even at room temperature and so interfere with the cross-matching of bloods for transfusion. Such occasions are still rare enough to warrant reports of single cases of their occurrence. McCombs and McElroy found in the literature thirty-eight instances[2]. Among these were represented diseases as varied as cirrhosis of the liver, trypanosomiasis and pneumonia. With the exception of paroxysmal hæmoglobinuria, which occupies a unique position, there would seem to be no regularity in the behaviour of cold agglutinins in disease, although it may be pointed out that systematic clinical and serological investigation of the subject has been neglected.

During the past four years two patients have been encountered whose blood serum upon routine testing for transfusion agglutinated the cells of donors of the same group. Both were seriously ill with pneumonia of the variety which has been called in the United States 'atypical' or 'virus type'. The first case (*J.C.T.*) was not studied further, but in the second (*F*) it was found that the acute phase of the disease was associated with the presence of cold agglutinin in the titre 1 : 2,000. Entertaining the hypothesis that cold agglutinins in smaller yet measurably abnormal amounts might occur in other, less severe examples of atypical pneumonia, a quantitative titration of the cold agglutinin content of the blood serum has been carried out in 22 cases. The findings are herewith presented.

The serological method employed was the customary one using 0·2 ml. of serum serially diluted in small test tubes. (After the blood was withdrawn from the subjects it was kept at a temperature as near 37° as possible until the serum was separated.) 0·1 ml. of 2 per cent suspension of washed group *O* human erythrocytes was added to each tube, the racks set in the refrigerator and readings made the following morning. The results may be seen in the accompanying table.

NUMBER SHOWING TITRE OF:

	Total number	1 : 2 or less	1 : 4	1 : 8	1 : 16	1 : 32	1 : 64	1 : 128	1 : 256 or more
Atypical pneumonia	22	5	1	3	1	2	3	5	2
Controls	29	17	5	6	1	0	0	0	0

Note should be made not only of the obvious quantitative differences in titre, but also that no less than 10 pneumonia sera produced a hard, solid disk of agglutinated cells. This is in sharp contrast to the delicate clumping usually seen in the controls, none of which showed a disk.

The controls represented a number of infections, including pyelitis, osteomyelitis, empyœma, hæmolytic streptococcus sore throat, and 'grippe'. In this group are included also five examples of pneumococcus infection in which the organism was isolated from the sputum and in which there occurred a prompt and sharp recovery following administration of sulphadiazine.

The label 'atypical' pneumonia is given for want of a better. The epidemic proportions assumed by this disease during the past few years both in the civilian and military populations of the United States have given it an important place among respiratory diseases in the mind of the American physician. All of the cases in this group were thought by the clinicians to have atypical pneumonia, although not all were acutely ill when the test was performed. However, some of them may well have been pneumococcal, and nothing could be clearer than the necessity for a thoroughgoing bacteriological study, joined with the titration of cold agglutinins, in a much larger number of cases. In many of the patients reported upon here, all of whom were soldiers in the overseas forces of the U.S. Army, bacteriological investigation beyond that required for immediate clinical treatment was often difficult. A more comprehensive attack upon the problem is being undertaken. Meanwhile, on the basis of findings in several examples of definite instances of atypical, non-pneumococcal pneumonia, it would appear likely that the titre of cold agglutinins in the serum rises during the acute period of this disease, in contrast both to the convalescent phase and to pneumococcus pneumonia.

In this respect it is of much interest that one of the first clinical contributions to the subject of auto-agglutination consisted in a description of the rise and fall in titre of cold agglutinins in the blood of a patient who had prolonged and rather unusual pneumonia. Pneumococci were not found in the sputum: the illness lasted some four weeks[3]. More recently, two not dissimilar cases have been noted[4]. If to these are added the two instances commented upon earlier in the present communication, pneumonia is seen to be responsible for an appreciable number of the recorded occurrences of cold agglutinin in amount sufficient to interfere with cross-matching of blood. Quantitative serological studies, together with proper bacteriological examinations, should clarify the relation of pneumonia to the cold agglutinins, and indicate furthermore whether this type of agglutinin is, in fact, non-specific.

Joseph C. Turner.

Medical Corps,
U.S. Army.
March 12.

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[1] Landsteiner, K., and Levine, P., *J. Imm.*, **12**, 441 (1926).

[2] McCombs, R. P., and McElroy, J. S., *Arch. Int. Med.*, **59**, 107 (1937).

[3] Clough, M. C., and Richter, I. M., *Johns Hopkins Hosp. Bull.*, **29**, 86 (1918).

[4] Sherman, I., *Amer. J. Med. Sci.*, **188**, 487 (1934).

'Condensation' in Fermi-Dirac Statistics

Recently London[1], Tisza[2] and others have studied in detail the peculiar condensation phenomena for a Bose-Einstein gas because of its possible application to liquid helium II. As is well known, the condensed phase occurs in a Bose-Einstein gas when for a given temperature T and volume V, the number (N) of particles exceeds the value N^* given by neglecting the effect of relativistic mechanics,

$$N^* = Vg\left(\frac{2\pi mkT}{h^2}\right)^{3/2}\zeta(\tfrac{3}{2}),\quad \zeta(\tfrac{3}{2}) = 2{\cdot}61,$$

where m is the mass of a particle, g its weight factor by virtue of its internal structure, and the other symbols have their usual meaning. The condensed phase is populated by ($N - N^*$) particles lying in the zero energy state. In this note the possible existence of a condensed phase for a Fermi-Dirac gas is discussed.

Born[3] in a recent paper has shown that according to the reciprocity principle the number $a(p)dp$ of wave-functions of a particle, the momentum of which lies within the range p and $p + dp$, is given by

$$a(p)dp = \frac{4\pi Vg}{h^3}\frac{p^2\,dp}{(1-p^2/b^2)^{1/2}}, \quad . \quad . \quad . \quad (1)$$

where b is the maximum value possible for momentum, that is, b is the upper limit of p. The total number of wave-functions (a_0) possible, therefore, in a region of volume V is (according to Born),

$$a_0 = \int_0^b a(p)dp = \frac{g\pi Vb^3}{h^3}. \quad . \quad . \quad . \quad (2)$$

As in the case of a Fermi-Dirac gas any independent wave-function cannot accommodate more than one particle, equation (2) imposes an upper limit ($N \equiv N_0 = a_0$) on the number of particles that can be contained in volume V.

What happens when the number of particles N introduced in the given volume exceeds N_0? To answer this question we revert to (2). In replacing the sum of all possible eigen-states extending from ($p = 0$) to ($p = b$) by the integral in (2), the total number of eigen-states has become limited though it is in reality infinite, for the number of eigen-states corresponding to $p \to b$ is infinite. The total number a of states is

$$a = a_0 + a_1,$$

where a_1 denotes the infinitely large number of states corresponding to $p \to b$. It follows, therefore, that when the number of particles N present in the assembly exceeds N_0, a *condensed* phase containing ($N - N_0$) particles will be formed, all the particles in the condensed phase possessing the momentum b.

In the case of a Bose-Einstein gas the condensed phase is formed by particles in the zero energy state, whereas for a Fermi-Dirac gas the condensed phase (its existence depending upon Born's reciprocity theory) is formed by particles in the highest energy state corresponding to $p = b$.

This condensed phase will obviously be significant for astrophysical applications of the reciprocity theory, but these will not be considered here.

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Brij Nath.

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[1] London, F., *J. Phys. Chem.*, **43** (1939).

[2] Tisza, L., Nature, **141**, 913 (1938).

[3] Born, M., *Proc. Roy. Soc.*, A, **165** (1938).

Frictional Properties of Metallic Films

Experiments, to be described elsewhere, in which the electromotive force generated by a loaded rotating steel ball in frictional contact with a metal block was measured, showed that the steel ball tended to pick up metal from the flat surface, and that metallic films wiped out on metal surfaces by hand affected both the magnitude of the electromotive force and the size of the final wear impression. Films of tin, copper, lead and zinc wiped out on Timken test blocks reduced the electromotive force in this order of merit when no oil had been applied to the contact. On the other hand, a film of tin rubbed on to the flat surface of a hardened steel roller led to an increase in both the electromotive force and the diameter of the final wear impression, and a film of lead rubbed on to a block of copper had a similar effect.

Even in those cases in which the films reduce the electromotive force under 'dry' conditions, they do not appear to function as a lubricant for a brief interval until normal lubricating conditions are re-established, as has been suggested on the ground of experiments with the Bowden-Leben apparatus[1]. Of the four metallic films, the film of lead was the only one to reduce the electromotive force appreciably and to delay transition to tearing in the presence of a straight mineral oil. With an extreme-pressure addition, such as 2 per cent of chlorinated paraffin-wax, the metallic films cause an increase in the electromotive force in the order 'no film', lead, tin, copper, in which they promote corrosion.

These results are essentially different from those reported with the Bowden-Leben apparatus[1,2], which has the peculiarity that a hemisphere is made to plough a groove on a flat surface. The resistance to ploughing depends upon the shear strength of the portion of the metal which is to be ploughed up, and decreases as *one* groove is being worn in. Thus, the decrease in the resistance to ploughing found with a lead-copper alloy in the course of fifty strokes in the same track and at the same load does appear to be the trend which can be expected with any metal that is softer than the hemisphere, and it does not prove that "in a heterogeneous bearing metal the soft phase wipes out over the hard phase during sliding". The view that the ploughing action is the essential feature of the Bowden-Leben apparatus when the hemisphere is the harder of the two friction elements finds support in Bowden and Tabor's observation that for any given *track-width* the friction is the same on bulk indium as it is on indium films on a steel substrate.

ROBERT SCHNURMANN.

Physics Department,
Manchester Oil Refinery, Ltd.,
Manchester.
March 8.

[1] Heaton, J. L., Bristow, J. R., Whittingham, G., and Hughes, T. P., NATURE, 150, 520 (1942).

[2] Bowden, F. P., and Tabor, D., NATURE, 150, 197 (1942).

Magnitudes of Lightning Currents

THE magnitudes of the total peak currents in lightning flashes have been over-estimated hitherto, due to the assumption made as to the relationship between the peak currents in individual discharge paths and the total peak current in any one flash.

Several methods have been used to determine the magnitudes of the current in lightning discharges to earth[1]. Most of these methods involve a knowledge of one or more parameters of the lightning flash, such as its length and the velocity of the return stroke, or the shape and the duration of the current wave. Direct measurement of the current amplitudes became possible by the installation of magnetic links which indicate the peak value of the current discharged through a metallic earthed conductor on which they are mounted. During the last ten years, more than a thousand lightning flashes to transmission lines with earth wires have been investigated by means of magnetic links in various parts of the world, and frequency-distribution curves of current magnitudes have been given.

The method which has so far been universally used for obtaining the total current in the lightning channel is based on the assumption that the currents in the various paths to earth are in phase, that is, that the current peaks occur simultaneously in the tower struck and in the adjacent earth wire. The total lightning current was then obtained by adding the crest values of the individual currents. In cases where magnetic links have not been installed on the earth wire, the total current has been taken as the sum of the currents in all the towers affected, thus tacitly assuming that the peak values even of currents in adjacent towers occur simultaneously.

I have now evolved a new method of calculation which is based on a quasi-stationary determination of the distribution of a lightning current in the various parts of a transmission system on the assumption of an average double exponential current wave. Calculations, which will be reported more fully at a later date, show that the crest of the current which is discharged through the tower struck occurs during the front of the total lightning current wave, whereas the crest values of the currents in the earth wire and therefore in the neighbouring towers occur always during the period corresponding to the tail of the total current wave. The phase differences between the component currents vary with the geometrical dimensions of the transmission lines and increase rapidly with decreasing tower footing resistances. It therefore follows that lightning currents calculated according to the old method are too high, and it can be shown that the resulting percentage error increases rapidly with increasing tower footing resistance up to a maximum of 40–50 per cent; this maximum occurs within the most common resistance range, that is, between 10 and 20 ohms, after which the error decreases very slowly for higher resistance values. It can thus be seen that the maximum and average current values, so far accepted as being approximately 220 kiloamp. and 20 kiloamp., respectively, can now be taken to be of the order of 160 kiloamp. and 15 kiloamp. respectively.

Several investigators[2] have recently obtained magnetic-link records on single lightning conductors and have commented on the smaller crest values compared with those formerly accepted. The new theory provides an explanation, and it is interesting to note that, though the number of observations is too small to form the basis for a new distribution curve, the current magnitudes fall within the range now suggested.

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[1] Bruce, C. E. R., and Golde, R. H., *J. Inst. Elec. Eng.*, 88, Part II, 487 (1941).

[2] Wagner, C. F., and McCann, G. D., *Elec. Eng.*, 60, 483 (1941). Gross, I. W., and Lippert, G. D., *Trans. Amer. Inst. Elec. Eng.*, 61, 178 (1942).

Potatoes and War Economy

IN connexion with Prof. Lysenko's communication to Sir John Russell on some unorthodox emergency methods of potato propagation[1] the following observations may be both relevant and complementary.

Since 1937, Mr. Alexander McI. Cleland of 'Macedon', Green Road, Knock, Belfast, has been carrying out experiments on the cultivation of potatoes (Albert Victor purple variety) from tuber *cuttings*, as well as *peelings*. The experimental plot had a light loam soil based on glacial sand, and was divided into beds 4 ft. in width, which received no treatment, apart from turning over and occasional weeding. Early in spring, tuber cuttings, each containing an 'eye' attached to a piece of potato (about ½ in. in diameter and ¼ oz. in weight) were planted in shallow boxes; towards the end of May the sproutings were re-set in the plot 9 in. apart. At the end of the season, 288 'eyes' from 24 lb. of potatoes yielded 804 tubers weighing 172 lb., in addition to a large number of seed potatoes.

In the case of peelings, as represented by freshly collected kitchen waste, they were broadcast (avoiding overlapping) on to a garden bed and lightly covered with soil, the operation being carried out at regular intervals between the beginning of May and mid-June. The plantings readily sprouted, yielding at the end of the season 32 lb. of usable potatoes, as well as many seed potatoes. The crops were free from disease (in agreement with the Russian observations) and of good quality.

This great difference in yield scarcely represents, however, the relative merit of the two methods of propagation. Apart from the 'eyes', made defective prior and during the peeling, the time and manner of planting puts the peeling procedure at a disadvantage which could no doubt be rectified by improved co-ordination. Again, although the yields recorded here are below those attainable under intensive or even normal conditions of cultivation, they have the redeeming feature of constituting an *additional* crop. Thus in cases where the land and labour problem is dominated by the need to conserve existing stocks of potatoes, as in the U.S.S.R. now, such emergency methods of propagation may be justified in practice. The trade in certified seed "potato-eyes" fostered in North America[2] and the sporadic, small-scale cultivation of potatoes from detached sprouts or tuber cuttings in Great Britain[3] add local colour and emphasis to the vast agricultural efforts now being made in the U.S.S.R.

As regards the acceleration of seed potato sprouting (loc. cit.[1]), the mechanical removal of the protecting skin could perhaps be substituted by such treatment as oxidation with potassium permanganate, or dissolution of the outer covering with cuprammonium sulphate, followed if necessary by contact with organo-mercury compounds, effected by a conveyor belt dipper[4].

Maurice Copisarow.

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Manchester, 16.

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[1] Nature, 150, 456 (1942); 151, 77 (1943).

[2] *Amer. Potato J.*, 14, 23 (1937).

[3] Polunin, *Gard. Chron.*, January 23 (1943).

[4] Wakely and Mellor, Nature, 150, 769 (1942).

Physiology of Colour Vision

The article by E. N. Willmer in Nature of February 20 is interesting, but there is no evidence that the rods are percipient elements; rather there is overwhelming evidence that they are nerve elements sensitizing the film round the cones with the visual purple. The displacement of the positive after-image proves conclusively that the primary stimulus in vision is liquid, the muscles of the eye having a double function, one to move the eye, and the other by pressing on the back of the eye and shifting the photochemical film in the direction in which the eye is moved. The negative after-image remains in its primary position, but the positive after-image is seen farther on in the direction in which the eye is moved. This can easily be seen with a light, or even with an area of colour on a white ground. If, for example, a red square on a white ground be looked at for as short a time as possible and then the eyes be directed at a point immediately above the square, a green negative after-image will be seen at this point and higher up a distorted positive after-image or a series of red dots on a light red ground exactly similar to the cones of the retina viewed under a high-power microscope. There is no persistence of vision in ordinary circumstances when the eye is moved, but when the hand is moved in front of the eyes a dozen or more hands will be seen.

F. W. Edridge-Green.

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London, N.W.2.

Mr. E. N. Willmer has proposed an interesting hypothesis of colour vision[1]. It is not possible in the length of this letter to cover all the points that Mr. Willmer has raised. I will limit myself to two only, namely, colour mixture and adaptation.

According to Mr. Willmer's hypothesis, the parts of the spectrum lying between the red and the violet are perceived by stimulation of the rod and the cone elements in certain fixed ratios; whereas the red end of the spectrum stimulates the cones only, the violet end of the spectrum stimulates the rods only. According to this hypothesis, it should therefore be possible to match all the colours of the spectrum in turn by suitable mixtures of red and violet rays. Experiment demonstrates conclusively, however, that such mixtures yield crimsons and purples; so that in this case hypothesis and experiment are apparently at variance.

I should expect, from Mr. Willmer's hypothesis, that exposure of the eyes to violet rays would depress for a time the sensitivity of the rod retinal perceptors. If then, immediately after such an exposure, the eye be directed at a white surface, one would expect this to appear tinted with red for a short time, due to the temporary predominance of the cone receptors. Experiment, however, shows that the white surface is tinted not with red but with yellow; so hypothesis and experiment apparently do not agree. On exposure of the eye to red rays, according to Mr. Willmer's hypothesis, the white surface, for similar reasons, should appear to have a violet tint. Experiment, however, shows that the tinting is greenish-blue, so that again hypothesis and experiment apparently do not agree.

If there was a dearth of theories on colour vision, Mr. Willmer's hypothesis would be acceptable even if it did not fit in with all the observed facts, because any theory is of value which acts as a stimulus for further research. But there are endless theories of colour vision, many of which, after a short life, have met with a deserved and unregretted end. I hope Mr. Willmer will clear up the apparent divergencies I have pointed out above between what seem to me to be conclusions from his theory and the experimental facts.

H. Hartridge.

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London, E.C.1.

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[1] Nature, 151, 213 (1943).

Minimum Human Requirements and the Beveridge Report

It is a matter for satisfaction that Sir William Beveridge has, in his report, recognized the principle that quantitative standards based on scientific knowledge may, and should, be applied to the measurement of minimum human requirements in food, fuel, light and clothing. As medical knowledge advances, and as cultural demands change, any standards of this nature will be gradually modified, though there can be no doubt that those for food have now been determined with a fair degree of scientific accuracy. We would express our conviction that the food standards now proposed for Great Britain, based as they are on the scales laid down by the British Medical Association and the League of Nations Technical Commission, accord with the opinion of all accredited scientific workers in this particular field.

It is not our business to decide what shall be the actual scales of cash benefit and allowance under any system of social security. That decision rests with the people of Great Britain and with their elected representatives. But we do urge that all such scales shall, in future, be related immediately to the scientifically estimated needs of each type of beneficiary.

Joseph Barcroft.
Stanley Davidson.
F. Gowland Hopkins.
Horder.
Julian Huxley.
J. M. Mackintosh.
Charles Martin.
R. McCarrison.
Moran of Manton.
B. S. Rowntree.
J. C. Spence.
W. H. Wynn.

LAW OF THE MOVING-IRON ELECTRICAL INSTRUMENT

THE law of the moving-iron instrument has been given in the form, torque equals $\frac{1}{2}I^2 dL/d\theta$, where I is the current in the coil and $dL/d\theta$ the rate of change of inductance with angular deflexion. This law assumes the current remains constant for a small change in deflexion, but since a change in inductance is produced by a change in current, the assumption does not seem justifiable. The law therefore takes a more complicated form, and in a paper on the subject (*J. Inst. Elec. Eng.*, 90, Pt. II, No. 13, February 1943) Dr. G. F. Tagg describes experiments which show that the simple law does not hold for a simple electromagnetic system, and it is considered that the law as enunciated in most text-books is incorrect.

Moving-iron instruments do not generally lend themselves to any simple theoretical treatment, and the very nature of the instrument makes any calculation of the current-torque relation very difficult, if not impossible. It is stated in the proof of text-book equations governing the law that the energy of the coil is $\frac{1}{2}LI^2$ and that it is a change in this energy which produces the pull. The pull is exerted on the iron, and there is no justification for assuming that the whole of the magnetic energy is used to produce it. It is the magnetic potential of the iron which matters, and this is not necessarily the same as that of the coil. Again, the statement is made "if the current remains constant"; but this cannot apply as a change in current produces a change in deflexion, and it is not possible to have an effect and to assume that the cause is zero.

It is suggested that the true equations are, in the case of an angular deflection θ, the torque

$$T = \frac{d(\frac{1}{2}\eta LI^2)}{d\theta} = \frac{1}{2}\eta I^2\frac{dL}{d\theta} + \frac{1}{2}I^2L\frac{d\eta}{d\theta} + LI\eta\frac{dI}{d\theta},$$

and that for a linear deflexion x, the pull

$$F = \frac{d(\frac{1}{2}\eta LI^2)}{dx} = \frac{1}{2}\eta I^2\frac{dL}{dx} + \frac{1}{2}I^2L\frac{d\eta}{dx} + LI\eta\frac{dI}{dx},$$

in which η represents the magnetic efficiency. The available energy to produce torque or force is $\frac{1}{2}\eta LI^2$; η, L and I can all be regarded as functions of x.

The true expression for the torque or pull is thus more complicated than the simple ones usually put forward and involves a quantity η, the 'magnetic efficiency', the value of which it is practically impossible to predetermine. It is therefore a matter of extreme difficulty to forecast the behaviour of any particular instrument, and experiment appears to be the only solution.

Dr. C. V. Drysdale, dealing with the "Torque of Soft-Iron Electrical Instruments" (*J. Inst. Elec. Eng.*, 90, Pt. II, No. 13, February 1943) shows that the inductance formulæ $F = \frac{1}{2}I^2\delta L/\delta x$ and $T = \frac{1}{2}I^2\delta L/\delta\theta$ are correct for iron-cored instruments if the magnetization of the iron does not exceed the maximum value permissible for accurate indication. For higher magnetizations the force or torque is higher than the value given by the formulæ, and becomes twice as great when the iron approaches saturation.

The inductance method of calculating the torque of electromagnetic instruments is so valuable, both for design purposes and for the experimental shaping of the moving iron without the laborious process of dismantling, rebalancing and reassembling the movement for each modification, that it has now been fairly widely adopted. The experiments carried out by Dr. Tagg referred to above have led him to claim, however, that the method is based on unjustifiable assumptions and has no experimental confirmation; it is true that it is applicable only when the magnetization of the iron does not exceed a certain value; but this limitation does not affect its utility for the development of accurate instruments.

In view of the above claim and of the importance and limitation of the method, it is desirable that its theory should be completed, established and extended. It is based on the principle of the conservation of energy, and is so closely analogous for electrostatic and electromagnetic instruments that it is advantageous to consider them together; this is done in the paper referred to. It is shown that the formulæ already mentioned are applicable to soft-iron instruments if the magnetic flux on the iron is proportional to the current. For electrostatic instruments the capacitance is independent of the potential difference, so that the formulæ $f = \frac{1}{2}V^2\delta C/\delta x$ and $T = \frac{1}{2}V^2\delta C/\delta\theta$ are always valid. The paper also discusses the effect of variable permeability of the iron circuit of electromagnetic instruments.

PRESERVATION OF TIMBER IN RHODESIA

R. H. FINLAY, forest officer, Department of Agriculture, Rhodesia, has discussed the preservation of timber in that country (*Proc. Rhodesia Sci. Assoc.*, 39, 103; 1942). After dealing with some of the earliest methods of utilizing durable timbers, Mr. Finlay comes to the period when, with the greater utilization by man of varying timbers from the forests and the consequent necessity for extending the period of utility of the softer woods, attempts were made to introduce preservative treatment. Mercuric chloride and copper sulphate had already been recommended in the eighteenth century, but methods of treatment with these were not patented until the 1830's. In 1832 Kyan patented a method based on mercuric chloride or corrosive sublimate, which came to be known as 'kyanizing'. Sir William Burnett then made use of zinc chloride, and the method was patented in 1838. Originally this consisted in immersing the timber in open tanks of zinc chloride; the method is still used. Later it was modified to a pressure process known as 'burnettizing'. Creosote, even more familiar to-day on the countryside in England, was also experimented with at this time, and in 1838 John Bethell was granted a patent to inject creosote under pressure. The modern Bethell or full-cell process is the direct outcome of this process. As is well known, attention became more and more fixed on the use of creosotes and mixtures containing it, and they hold high rank to-day.

In recent years the market has had a sequence of proprietary preservatives, but for the most part they cannot be said to be truly established as commercial timber preservatives. Moreover, as Mr. Finlay goes on to show, different climatic conditions affect very considerably the methods which it may be possible to introduce. For example, protection against the termite may vary in dry hot as against moist hot localities. Further, there are innumerable borer and fungus attacks to be considered, including the marine borer. An interesting example of present knowledge on the subject is connected with a fungus growth known as 'blue stain'. Some timbers, and perhaps specially the softer types of broadleaved trees, when freshly cut from the green log, grow a fungus within a few days which gives a blue colour to the timber. The stain, as a matter of fact, has no effect on the soundness or durability of the wood, but it has not proved possible to convince the purchaser of this, and thus the price is either seriously affected or the wood becomes unsalable, and this within a very short time. Research has resulted in a cheap bath or spray becoming available with which the wood is treated before the fungus appears. In Rhodesia the spray known as 'dowicide P.', composed of a mixture of sodium tetrachlorophenoxide and sodium di-chloro-ortho-phenyl-phenoxide, is used. Since some of the tropical forest areas within the British Empire contain considerable amounts of soft-wooded hardwoods, which, if they can be marketed, would save the imports of coniferous timber at considerable cost which was so common up to 1939, the discovery of this treatment should be of assistance to various forestry departments. The author gives in his paper details of the methods of applying preservatives.

The question of imports of timbers, mostly coniferous soft woods, into Colonies which possess a certain or considerable area of forests, is considered by Mr. Finlay in a second paper published in the same journal (*Proc. Rhodesia Sci. Assoc.*, 39, 88; 1942) under the title "Post-War Employment and the Timber Industry". In so far as timber products are concerned, any new industry would have an indirect subsidy for a number of years through lack of shipping space and the enormous demand on the forests of the world which the vast repairs to damaged cities and houses on the countrysides will entail. Rhodesia from its geographical position will have to be self-dependent, he considers, at any rate in soft woods. He considers this should be feasible though he makes an interesting remark on the subject of these timber imports; the first of these are "Oak and Teak, woods of such universal popularity that there is little or no hope of their ever being eliminated from the list of imports". Yet there are those in Britain who consider the valuable hardwoods no longer worth growing.

GAMMA-RADIOGRAPHY

A PAPER on gamma-radiography was read by Mr. C. Croxson at a meeting of the Industrial Radiology Group of the Institute of Physics, held at Loughborough College, Loughborough, on February 27. Mr. Croxson explained that gamma-radiography is complementary to radiography by X-rays, the chief advantages of radiography by a gamma-ray source being due to the high penetration of gamma-rays and to the fact that a source of gamma-rays is relatively small and can therefore be used in locations quite inaccessible to an X-ray equipment. In the past, sources of up to about 250 mgm. of radium element have been used, but recent work has shown that radon (radium emanation) sources are superior for some work since, for the same source size, radon has an initial intensity sixty or seventy times greater than that of radium: with the smaller source sizes thus obtainable, source-film distances of as low as three inches become practical without serious loss in definition. The main disadvantage lies in the short half-life period of radon of about 3·85 days compared with 1,590 years for radium, but since the decay-rate is known, exposures can be readily calculated from exposure curves worked out for radium sources of known intensity. As a war-time measure, the radium is transported in a steel container, three inches thick. For use, the gamma-ray source is transferred to an exposure bomb which has an aperture for the emerging beam, the container being carefully designed to avoid scattered radiation marring any radiograph made.

In making a radiograph, the gamma-ray source is carefully positioned on one side of the specimen and the photographic film is placed on the side of the specimen remote from the source, the object-film distance being kept as small as possible to reduce geometric unsharpness and image distortion. Ordinary X-ray films are used for the work. Where maximum speed is essential despite unsharpness, calcium tungstate intensifying screens should be used with the so-called screen-type X-ray films. Somewhat lower speed but better definition is obtained by exposing the film between lead intensifying screens: in these circumstances the direct or 'non-screen' X-ray films give maximum contrast, but 'screen-type' films may be used at the expense of some slight loss in contrast. Compensation for the lower speed may be achieved by exposing two films simultaneously in a lead-screen/film/lead-screen/film/lead-screen pack: alternatively, the same technique may be used to obtain two copies of the radiograph at one exposure. Over-development, up to ten minutes, is regularly made use of to give increased film density or reduced exposure time. Curves were shown illustrating how the speed of tungstate screens varies with the thickness of the coating for X-rays generated at various kilovoltages and for gamma-rays. Other curves showed how the speed factor of tungstate screens decreases as the thickness of metal increases—a most unfortunate property. Further increase in speed may be attained by special techniques such as hypersensitization before exposure or chemical intensification of the developed image. Owing to the reciprocity failure of the photographic materials, the exposures when using tungstate screens cannot always be calculated accurately by the inverse square law, and curves were shown from which the appropriate factors could be deduced.

For routine work, the ideal exposure time is about fifteen minutes: these short exposure times are attained by reducing the source-film distances, but a limit is imposed by the degree of definition necessary.

The short wave-length of gamma-rays, which incidentally correspond in penetration to X-rays generated at 200–2,000 kV., renders them highly suitable for the radiography of heavy metals, and Mr. Croxson reported that they have been used effectively in the radiography of tungsten steels, tungsten carbide, stellite and lead alloys in addition to their well-known application in the inspection of ferrous, coppe and brass specimens. The low radiographic contras obtained in gamma-radiographs makes the techniqu ideal for the inspection of specimens having wide ranges of thickness. Moreover, the effect of scattere radiation is not so serious as when X-rays are used the chief precaution necessary is to back the cassett with lead about 1 mm. thick to avoid back-scattere radiation reaching the film.

For these reasons, gamma-radiography is very suitable for the detection of hot tears, shrinkage defects blowholes, sand inclusions and cracks in heavy and often complex castings. Several slides were show illustrating the characteristic appearances of these defects as revealed in the gamma-radiographs. The method is of particular value in the critical examination of pilot castings in indicating the soundness of the foundry technique. Since such heavy castings are usually costly, the defective regions are often cut out and afterwards welded. Further radiographic examination will reveal the soundness of the repaired section. Welded repairs of this kind may show cracks in the weld or parent metal at the edge of the weld, and Mr. Croxson pointed out that, since these cracks are tortuous and not necessarily in the same plane as the incident gamma-ray beam, great care must be taken in interpreting the radiograph. If any suspicious shadow is seen, another radiograph should be taken in one or more other directions to ensure that the presence of a crack is either confirmed or refuted. Similarly, gamma-radiography may be used for the examination of all types of welds, and the method has advantages over radiography by X-rays when cylindrical objects are being examined: apart from the fact that the radiographic inspection of welds reveals defects, the knowledge that the method will be applied has the moral effect of making welders even more careful in their work.

In concluding, Mr. Croxson said that his experience of gamma-radiography justifies high confidence in the rapid extension of this specialized inspection technique.

STALIN PRIZES FOR SCIENCE, INVENTIONS AND INDUSTRIAL TECHNOLOGY

THE following have been awarded Stalin Prizes (first class) for outstanding achievements and inventions and for improvements of the technology of industrial production in 1942. First Class prizes carry an award of 200,000 roubles each (150,000 roubles in the "outstanding inventions" section):

Physics and Mathematics: P. A. Alexandrov, for studies in mathematics; P. Kapitza, for research on helium.

Technical Sciences: L. S. Leibenzon, for studies on the theory of elasticity and oil mechanics; M. A. Pavlov, for research in the technology of iron smelting.

Chemical Sciences: A. N. Nesmeyanov, for researches on metallo-organic compounds.

Geology and Geography: F. N. Krassovsky, professor of the Moscow Institute of Engineering, Geology and Cartography; P. I. Stepanov, for geological researches on the Donets Basin, summed up in his work "Geology of the U.S.S.R.".

Biology: P. M. Zhukhovsky, for his work "Botany" and for his discovery of new varieties of wheat and rye and the development from them of hybrid varieties of great economic value; V. A. Engelgardt and M. N. Lubimova, for researches on muscles.

Agriculture: T. L. Lysenko, V. P. Mosolov and a group of scientific workers, for development and introduction of a method of using tops of potato tubers for cultivation.

Medical Sciences: V. N. Shevkunenkoz, lieut.-general of the Medical Service, professor of the Military Medical Academy of the Red Army; A. N. Maxinenkov and A. S. Vishnevsky, professors of the same Academy, for the scientific work "Atlas of the Nervous and Venous System".

Philosophy: G. Alexandrov and B. E. Bykhovsky, M. B. Mitin, P. F. Yugin, O. Trakhtenberg and V. Asmus, for the work "History of Philosophy", in three volumes.

For many years' outstanding work in Science and Technique: M. J. Averback, First Medical Institute; A. A. Baikov, Leningrad Polytechnical Institute; B. E. Vedeneyev, Assistant Commissar for Electric Power Stations; V. I. Vernadsky; S. N. Dzhanashya, member of the Georgian Academy of Sciences; B. D. Grekov, the University of Leningrad; I. I. Meshchaninov, director of the Speech and Thought Institute, Leningrad; V. F. Mitkevich, Leningrad Polytechnical Institute; S. S. Nametkin, director of the Institute of Combustible Minerals; A. E. Forai Koshits, "Lensoviet" Leningrad Chemico-Technological Institute; N. P. Chizhevsky, K. I. Shenfer.

For outstanding Inventions and Improvements of Production Methods: N. Blokhin, chief engineer of the Central Board for Special Steels; A. Sheremetyev, director of the Board, and a group of engineers of various works and scientific institutes, for the elaboration and introduction into industry of a new technological process of steel smelting for war industry. V. Grabin, lieut.-general of Engineering Troops; Ivanov, lieut.-general of the Artillery Engineering Service, and the assistants of the chief constructor of the Central Artillery Designing Bureau; P. Nazarov and D. Sheffer and others, for designing new types of ordnance. A. Derkach, engineer of Works No. 695, and a group of engineers of Scientific Research Institute No. 20, for designing new types of radio equipment. Z. Yermolyeva, director of the Department of Biochemical Bacteriology, All-Union Institute of Experimental Medicine, and L. Jakobson, director of a laboratory of the Institute, for the development of a new method of early diagnosis and phagocytic-prophylaxis of contagious diseases. S. Ilyushin, aircraft designer, for modifications and improvements in design of warplanes. Y. Kozhevnik, head of the central board for production of steel tubing; J. Ossadchy, director of Works No. 703, and a group of engineers for improvement of the technology of production of mortar barrels and ammunition parts. V. Kotelnikov, head of a group of engineers of the Central Research Institute of Communications, for designing new communications equipment. J. Kotin, chief constructor of the Kirov Works; S. Makhonin, chief engineer, L. Troyanov, assistant chief constructor, F. Petrov, chief constructor of Works No. 9; S. Gurenko, chief constructor of Work Nos. 172, for designing a new type of artillery; N. Kuznetsov, major-general of the Artillery Engineering Service; A. Semenov, lieut.-colonel engineer, and a group of military engineers, for designing new types of arms. S. Lavochkin, aircraft designer, for modification and improvement of warplanes; H. Lurye, chief engineer of Ballbearing Works Nos. 4, 3 and 1, for organization of mass production of special bearings; B. Malinin, senior scientist of Central Research Institute No. 45, and a group of the staff of Central Designing Bureau No. 18, for designing a new type of warship; I. Maslennikov, director of the Experimental Research Institute for Metal-Cutting Machine Tools, and a group of the staff of the Bureau for Machine Tool Aggregates of the same Institute, for designing new highly efficient machine tools for war industry; N. Polikarpov, aircraft designer, for designing a new model of warplane. N. Rubtsov, Moscow "Baumann" Machine Building Institute, and a group of engineers and staff members, for improvement in the technology of ammunition production; P. Sukhon, aircraft designer, for designing a new type of warplane; A. Tupolev, aircraft designer, for the creation of a new type of warplane; A. Charomsky, aircraft engine designer, for a new type of aircraft engine. A group of workers of Works Nos. 231, 659, 389, 702, for designing a new type of naval armament; A. Shevtsov, aircraft engine designer, for designing a new type of aircraft engine; A. Yakovlev, aircraft designer, for modification and improvement of warplanes.

FORTHCOMING EVENTS

Saturday, April 10

ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF THE ALLIED COUNTRIES IN GREAT BRITAIN (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1)—Educational Conference. At 10 a.m.—"The Function of a University in a Modern Community": at 2.30 p.m.—"Methods of Practical Co-operation between Allied Universities in the Future".

Saturday, April 10-Sunday, April 11

INSTITUTE OF PUBLIC ADMINISTRATION (JOINT MEETING WITH THE INSTITUTE OF INDUSTRIAL ADMINISTRATION AND THE METROPOLITAN AREA EDUCATION COMMITTEE OF THE NATIONAL ASSOCIATION OF LOCAL GOVERNMENT OFFICERS) (in the County Hall, Westminster, London, S.E.1).—Conference on "Post-entry Training for Administration—the Need for an Administrative Staff College".

Saturday, April 10

2.30 p.m.—Discussion to be opened by Mr. E. S. Byng.

Sunday, April 11

10.30 a.m.—Discussion to be opened by Prof. Harold J. Laski.

Thursday, April 8-Monday, April 12

BRITISH PSYCHOLOGICAL SOCIETY (in the Debating Hall of the Union Society, Oxford).—Extended General Meeting.

Thursday, April 8

8.30 p.m.—Prof. C. Burt: "British Psychology in War-time" (Presidential Address).

Saturday, April 10

Symposium on "Mental Attitudes in Time of War".

9.30 a.m.—Dr. R. H. Thouless: "Hatred of the Enemy".

10 a.m.—Prof. T. H. Pear: "Psychological Implications of 'Re-educating the Germans'".

10.30 a.m.—Mr. Ranyard West: "What are we to Think?"

Monday, April 12

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Dr. Raymond Firth: "The Coastal People of Kelantan and Trengganu, Malaya".

Tuesday, April 13—Wednesday, April 14

SOCIETY OF GLASS TECHNOLOGY (at Elmfield, Northumberland Road, Sheffield 10).—Annual General Meeting, and Conference on "Education, Technical Training and Research for Post-War Developments in the Glass Industry".

Wednesday, April 14

ROYAL SOCIETY OF ARTS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 1.45 p.m.—Mr. J. G. Crowther: "Science in Soviet Russia" (Trueman Wood Lecture).

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Dr. A. H. T. Robb-Smith: "The Classification of Medical Literature and Records"; Mr. C. E. Lee: "Documentation in the Transport Industry".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. C. Raymond Greene: "Frost-Bite and Kindred Conditions" (Hunterian Lecture).

Thursday, April 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. S. Sugden, F.R.S.: "Magnetochemistry" (Ninth Liversidge Lecture).

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Dr. G. D. Bengough, F.R.S., and Mr. V. G. Shepheard: "Fouling and Corrosion of Ships"; at 4.15 p.m.—Mr. R. W. L. Gawn: "Steering Experiments", Part 1.

Friday, April 16

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Mr. A. R. Dunton: "The Control, Specialized Testing and Use of some Modern Insulating Materials".

Saturday, April 17

BRITISH RHEOLOGISTS' CLUB (JOINT MEETING WITH THE MANCHESTER AND DISTRICT SECTION OF THE INSTITUTE OF THE RUBBER INDUSTRY) (at the Engineers' Club, Albert Square, Manchester), at 10 a.m.—Discussion on "The Rheology of Rubber and Rubber-like Materials" (Chairman: Mr. W. N. Lister).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTRICT OFFICER, and ASSISTANT DISTRICT OFFICERS, to the Somerset War Agricultural Executive Committee—The Executive Officer, Parklands, Trull Road, Taunton (April 14).

EDUCATIONAL PSYCHOLOGIST—The Secretary-Superintendent, Belfast Hospital for Sick Children, Belfast (April 15).

EDUCATIONAL PSYCHOLOGIST—The Secretary, County Education Offices, Castle Street, Exeter (April 16).

LECTURER IN CIVIL ENGINEERING at the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton 1 (April 16).

PRINCIPAL for the Whitwood Mining and Technical College—Mr. M. G. Swaine, Education Offices, 97 Smawthorne Lane, Castleford, Yorks. (April 17).

TEACHER TO TAKE PRACTICAL GEOMETRY in the Manchester School of Building—The Director of Education, Education Offices, Deansgate, Manchester (April 17).

PSYCHOLOGIST at the Child Guidance Clinic—The Secretary for Education, 6 Lampton Road, Hounslow (April 17).

TECHNICAL ASSISTANT, CHIEFLY FOR CULTIVATION AND CROPPING—The Executive Officer, Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs. (April 17).

TEACHER FOR GENERAL SCIENCE, PREFERABLY CHEMISTRY, PHYSICS AND SOME BIOLOGY, at the Southend-on-Sea Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (April 21).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT of the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 2 (April 29).

INSTRUCTOR FOR TRAINING RADIO MECHANICS, WITH GOOD QUALIFICATIONS IN THEORY AND PRACTICE OF RADIO WORK, AND A LECTURER IN MECHANICAL ENGINEERING, at the Rugby College of Technology and Arts—The Organizer of Further Education in Rugby, Rugby (April 30).

LECTURER IN ELECTRICAL ENGINEERING—The Principal and Secretary, Harris Institute, Preston.

ASSISTANT ENGINEER for the Georgetown Sewerage and Water Commissioners, British Guiana—The Secretary, Overseas Manpower Committee (Ref. 352), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

SPEECH THERAPIST—The Acting Director of Education, Education Offices, Becket Street, Derby.

IRRIGATION ENGINEER for the Irrigation Department, Government of Ceylon—The Secretary, Overseas Manpower Committee (Ref. 775), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

ASSISTANT ENGINEER for the British Guiana Public Works Department—The Secretary, Overseas Manpower Committee (Ref. 767) Ministry of Labour and National Service, Sardinia Street, Kingsway London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Trade Unionism: a Short Study Course for Scientifi Workers. Prepared by J. Kuczynski and a Study Group of the Centra London Branch of the Association of Scientific Workers. Pp. 44 (London: Association of Scientific Workers.) 1*s*. [22

Chemistry and the Petroleum Industry. By Dr. A. E. Dunstan. Pp 48. (London: Institute of Chemistry.) [22

Hannah Dairy Research Institute. Bulletin No. 8: The Productio of Artificially Dried Grass. By Dr. James McNair in association wit Dr. Alexander B. Fowler. Pp. 111. (Kirkhill, Ayr: Hannah Dair Research Institute.) [24

How to Keep Well in Wartime. By Dr. H. A. Clegg. (Issued for th Ministry of Health by the Ministry of Information.) Pp. 24. (London H.M. Stationery Office.) 3*d*. net. [24

Jamaica Constitution. Despatch from the Secretary of State fo the Colonies to the Governor of Jamaica, dated 10th February 194 (Cmd. 6427.) Pp. 14. (London: H.M. Stationery Office.) 3*d*. net. [25

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RELATION OF TECHNICAL EDUCATION TO THE BUILDING INDUSTRY

THE White Paper on "Training for the Building Industry", which has been issued almost simultaneously with the report of the Central Council for Works and Buildings, indicates that in this matter the Government is proposing to act in accordance with the main principles of the Memorandum on Training and Recruitment for the Building Industry, prepared for the Ministry of Works and Buildings by Mr. G. D. H. Cole on behalf of the Nuffield College Social Reconstruction Survey in 1941. Though there is no mention of a guaranteed week, it is clear that the Government is prepared to deal with the difficulty of 'wet time' and by some system of guaranteed employment eliminate the casual form of engagement which was formerly the most unsatisfactory characteristic of employment in the industry. On the second major requirement laid down by Mr. Cole, it may well be held that in undertaking to give the industry a guarantee of employment at a high level for a period of at least ten years, the Government has fixed its target too high. The White Paper suggests that a post-war reconstruction programme designed for ten to twelve years will require the labour force in the building industry to be built up over a period to about 1,250,000 men. That figure has already been seriously challenged both in relation to the building programme itself and relative to the competitive demands on available man-power in Great Britain in the post-war period.

The report of the Central Council estimates that there will be a deficiency in Great Britain of about 275,000 skilled craftsmen, even on the assumption that all the fully trained men return to the industry, and for some years normal apprenticeship training will do little more than make good the wastage in the increased ranks of the expanded industry. This estimate is accepted in the White Paper, and the proposals made in the report for a system of special training of adults to meet this deficiency over a period of less than two and a half years are adopted.

It is accepted in the White Paper as a basic principle that the industry must participate fully in and be associated, both centrally and locally, with the administration of the schemes of special training to be provided by the Ministry of Labour and National Service and with the process of selection for training. To give effect to this principle, the Government proposes to establish a Building Industry Advisory Panel, over which the Minister of Labour and National Service or his deputy will preside, which will cover all relevant labour questions arising in the building programme. Under this Panel there will be a Special Training Committee to consider such matters as the number to be admitted to training over a given period, the proportion between different occupations, the methods of selection, the curriculum of training, the nature of the trade test and the standard of proficiency qualifying for admission to the industry. Local advisory committees attached to the employment exchanges will be set up to assist in the selection of applicants for training, and full account will be taken of the special requirements and interests of the civil engineering as well as the building industry.

Besides this, the Government has adopted the major recommendation of the report and is prepared to establish without delay an Apprenticeship and Training Council for the building industry. This will be primarily representative of the industry, but will include representatives of other important interested bodies, as well as of all Government Departments concerned. It will be presided over by an independent chairman to be appointed by the Ministry of Works, and its primary function will be to observe and advise on all matters concerning the recruitment, education and training of young persons for the industry, both for craftsmanship and for management, and to encourage the development of craft apprenticeship schemes and student apprenticeship schemes on a comprehensive basis.

In addition to a comprehensive review of existing apprenticeship schemes, the definition of minimum standards to which approved schemes should conform, the maintenance of a register of apprentices in training under approved schemes and the issue of certificates on completion of training, the Council will naturally also have a close interest in the development of technical education for the industry, including pre-employment education and vocational training. It is agreed that the existing facilities for technical training in Great Britain, from the junior school level to the university, require careful survey in the light of the anticipated demands of the post-war expansion of the industry, and the Council should be able to make a valuable contribution in this field. It should also be able to assist as regards the training of instructors for technical education and of suitable entrants for the higher managerial posts in the industry.

The report itself makes detailed proposals for the constitution of the Council, and its fifty-one members should, it is suggested, include representatives of the Royal Institute of British Architects, the Institution of Civil Engineers, Institute of Builders, Institution of Structural Engineers, Institution of Municipal and County Engineers and others, and among the seven Government Departments specified is the Department of Scientific and Industrial Research. The chapter on technical education for building gives an able review of the present position, and suggests, first, that the industry has not yet made full use of the possibilities of the junior technical school and that the numbers involved are very small. The senior technical courses in building have likewise not been fully appreciated by the industry, and this in spite of the fact that the curricula provide a background of fundamental knowledge essential for those who are effectively to undertake supervisory and directive functions in the industry. University education in building has hitherto been almost entirely confined to architectural studies. In two universities only have courses leading to a degree in building science been established, but only that at Manchester is now in operation. Finally, in addition to the serious deficiencies in pre-employment education, both in the absence of facilities and of students, there is undue reliance on evening instruction; a primary need is for more day-time release. Evening education could provide rather for more advanced studies, which might be continued after the age of eighteen.

The proposals advanced in the report to remedy this situation are in striking harmony with those of the Nuffield College pamphlet "Industry and Education" (see NATURE, March 13, p. 287). First, an immediate increase in the facilities for junior technical school education in building in England and Wales and for trade-school education in building in Scotland is recommended, together with increased facilities for senior technical school education planned on a regional basis to serve the whole country. Secondly, the proposed Council should consider the early establishment of compulsory continuation education for young workers in the building industry between the school-leaving ages of fifteen and eighteen, even before such a system could be applied to all adults. A general system of reconstruction scholarships should be provided for students in the junior and senior technical schools and trade schools. In regard to curricula, it is suggested that half the time in the continuation schools should be devoted to vocational training and the remainder to physical training and to the fundamental studies in English and social subjects which are essential for effective citizenship in a modern democracy. Even the senior school courses should be broadened to include such subjects as current events, principles of citizenship, architectural and building history in relation to modern building, town and country planning, housing and economics in relation to problems of industrial management.

Thirdly, the report recommends that university courses in building should be developed and encouraged. This problem of facilitating a greater and more effective contribution by the universities to the development of this industry is in some ways the most difficult. The industry is not usually regarded by those outside as a profession for which they might reasonably prepare by university study, although those who have first-hand insight into the problems of modern scientific building are beginning to appreciate the value to the industry of men with the highest educational qualifications.

In the first place, the employment of university-trained men would meet the need for the increased control over materials which scientific research continues to bring about in ever-growing measure. The results of scientific research cannot be properly interpreted and applied except by one trained in the fundamental sciences and familiar with their technical application, no less than with the scientific methods of testing results. A sound knowledge of the fundamental sciences and their application to building should find as large a place in the education of the builder and of the architect. Once a regular avenue of entrance through the universities to the building profession has been established, men with this type of training and education should be invaluable in any large building projects; and their services, properly utilized, would lead to a more scientific and more intelligent use of materials. Influx of men equipped with this type of education should also help to raise the general status of the industry and assist in setting up standards of qualification, on the absence of which the report comments.

Finally, apart from stressing the importance of attracting men of high standard, the report urges the necessity of attention to the provision of highly efficient instructors for the special training and other schemes, and to the need for meeting the prospective demands for men to fill the supervisory and managerial posts in the expanded industry. Special training schemes for men of these types will also be necessary, as well as a considerable expansion in the facilities available in technical colleges and similar institutions.

The proposals of this report, which represent a solution of this problem acceptable to influential representatives of both workers and employers, have a wide interest, apart altogether from the endorsement of their essentials by the Government in the White Paper. From the educational point of view they indicate that the building industry is coming to appreciate the dependence of industrial and commercial progress upon the availability and support of the right kind of technical education. This hope, expressed by Mr. W. O. Lester-Smith in his recent book "To Whom Do the Schools Belong ?", like his further desire for closer co-operation between industry and education, is clearly in process of fulfilment, and the report on "Part-Time Day Education for the Adolescent" which has recently been issued by the British Association of Commercial and Industrial Education, describing the proceedings of a Conference at Rugby on September 29, 1942, affords further evidence in this direction.

What is most striking about the educational proposals, however, is their similarity with those advanced in the statement on "Industry and Education" referred to above, and to Dr. A. P. M. Fleming's address, "Education for Industry", to Section L at the British Association meeting at Dundee in 1939. The report on training for the building industry is clearly an application to the building industry of exactly those broad principles which are laid down in the Nuffield College paper. On the raising of the school age, the improvement of the quality of education at the earlier stages, the provision for continued part-time education—largely day-time education—the insistence on the limitations of evening classes, and the exclusion of vocational training from the common school, the report and the statement are expressing almost identical views. An even more forthright condemnation of the evening class system has recently been issued by the Association of Scientific Workers, whose *Journal* for February is devoted to education. Besides pressing for an extension of educational facilities, the *Journal* suggests that firms might make more use of their senior staffs as teachers.

The emphasis in all these statements on the necessity for a type of education which promotes adaptability, flexibility and mobility in the labour force as well as in management, the condemnation of the bias against manual occupations, and the refutation of the view that apprenticeship is obsolete or becoming obsolete, are encouraging signs. They demonstrate that industry and education are thinking of efficiency in no mere mechanical terms, as the references to the importance of wider cultural opportunities and the better and more instructed use of leisure also show. It is evident that industry is beginning to formulate more clearly its requirements, and to accept as its own responsibility the training of its recruits in a specialized technique.

Such plans, like those plans for education to which Sir William Jowitt had referred in his speech in the House of Commons at the end of last year on reconstruction, are put into their true perspective by the recent debates on economic policy. Whatever changes in our economy the War may enforce, Great Britain will still be dependent on imports of raw materials, but will be deprived of certain of the resources previously used to obtain them. The recognition of this position probably prompted several of the welcome references to scientific research and industrial efficiency in the economic debate, for we can only meet our requirements without lowering our standard of life by increased efficiency. It is indeed as a contribution to greater social and economic efficiency that the proposals of the Beveridge Report should be judged, however desirable they may be on other grounds.

The wisely planned development of the human resources, which are the ultimate source of all wealth and of success in reconstruction as well as of victory in war, is the one certain method of increasing efficiency that lies within our power. The stringency of the labour situation in Great Britain during the War has brought home to us the shortsightedness and neglect which has characterized our approach to the problem in the past, and it is well that education should be put in the forefront of a reconstruction programme. The reports of the factory inspectorate, the Select Committee on National Expenditure and the Industrial Health Research Board bear witness to our failure to pay due regard to the health and training of juvenile and adult workers, and to apply the experience so hardly acquired in 1914–18 as well as in the present War.

If the respective needs of industry and education can be met and harmonized, Great Britain can look forward to a period of rapid advance in both education and industry. The primary necessity, as the Nuffield College statement shows, is to improve the quality of labour and ensure an attitude to production which will inspire all those concerned with industry in an endeavour to raise productivity to the highest level. If labour is either inferior in quality or reluctant for any reason to give of its best, Great Britain's prospect of maintaining a high standard of living is poor indeed. Moreover, this requirement is powerfully reinforced by the existing age-structure of the British people. The scarcity of juvenile labour imposes on the nation the imperative obligation to improve its quality, both as producers and as citizens, to the highest possible point.

The proposals for training for the building industry must clearly be interlocked with the wider proposals for education in Great Britain to which the Government is already committed, and especially the raising of the school-leaving age. Quantitatively at least, the proposals are also linked with the magnitude of the building programme, and this forms an integral part of the general programme for reconstruction. They provide a further reason for urging the Government to declare its broad policy and initiate the enabling legislation within the framework of which co-ordinated and concerted action can be taken to deal with problems that are urgent, without risk of impeding or jeopardizing wider plans or projects which must await the conclusion of hostilities before they can be executed.

FRANKLIN'S EXPERIMENTS AND OBSERVATIONS ON ELECTRICITY

Benjamin Franklin's Experiments

A new edition of Franklin's "Experiments and Observations on Electricity". Edited, with a Critical and Historical Introduction, by I. Bernard Cohen. Pp. xxviii+453. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 22*s.* 6*d.* net.

The Harvard University Press and Mr. Cohen have performed a very useful service in making Franklin's "Experiments and Observations" accessible in this convenient form. Mr. Cohen has written an introduction comprising chapters on Franklin and science, electricity before Franklin, Franklin's work in electricity and on the editions of Franklin's book. It is intended to serve both as an introduction to the text and as a study of Franklin as a man of science. It gives evidence of much research and fulfils its purpose admirably.

It is interesting to learn that Franklin's experimental work in electricity was not begun until he was forty years old. He was then in a position to retire from business, and he hoped to be able to devote himself to science. But this hope was not to be realized, for in a very few years public affairs made such demands on his time that he had to give up his electrical experiments. In this he acted in accordance with the view expressed in a letter which he had written in 1750. "Had Newton been Pilot but of a single common Ship, the finest of his Discoveries would scarce have excus'd or atton'd for his abandoning the Helm one Hour in Time of Danger; how much less if she carried the Fate of the Commonwealth". He seems almost to the end of his long life to have cherished the hope of having leisure some day to resume his researches.

Mr. Cohen in his introduction gives a critical account of the various editions of Franklin's book. "Experiments and Observations on Electricity, made at Philadelphia in America, by Mr. Benjamine Franklin, and Communicated in several Letters to Mr. P. Collinson, of London, F.R.S." was first published in 1751. A second part followed in 1753 and a third in 1754, both again consisting mainly of letters from Franklin to Collinson; the third part included papers by Canton and by Colden. The three parts appeared in second and third editions. In fourth and fifth editions (1769 and 1774), both personally supervised by Franklin, the three parts were published in one volume and much additional material was included. It is the fifth edition that forms the basis of the book now published. The supplementary part ("Electrical and other Philosophical Letters and Papers") has not been reproduced in full, but only in a selection confined mainly to 'electrical' letters and papers.

It is interesting to notice that on the title-pages of the fourth and fifth editions, Franklin's name is followed by the letters F.R.S. He had been elected a fellow in 1756. He had already been awarded the Copley Medal in 1753. In announcing this award, on November 30, 1753, the president of the Royal Society referred to the recipient as having "deserved well of the Philosophical World, and of this learned body in particular; to whom he has at various times caused to be communicated many of the Experiments he has made". He goes on to make a very just assessment of the value of Franklin's work on the electrical nature of lightning: "though some others might have begun to entertain suspicions of an Analogy between the effects of Lightning and Electricity; yet I take Mr. Franklin to be the first who, among other curious discoveries, undertook to show from experiments, that the former owed its origin entirely to the latter; and who pointed out an easy method, whereby anyone might satisfy himself of the truth of the fact which he had so advanced". It is somewhat surprising, as Mr. Cohen points out, that he makes no reference to Franklin's invention of the lightning conductor.

Franklin's book (in its fourth and fifth editions) begins with a short letter to Collinson dated March 28, 1747. In this Franklin writes, "Your kind present of an electric tube, with directions for using it, has put several of us on making electrical experiments, in which we have observed some particular phenomena that we look upon to be new. . . . I never was before engaged in any study that so totally engrossed my attention and my time as this has lately done". In his second letter, dated July 11, 1747, he gives a remarkably good account of "the wonderful effect of pointed bodies both in drawing off and throwing off the electrical fire". In the same letter he introduces the terms positive and negative, or plus and minus, to describe the two ways in which a body may be electrified. On September 1 of the same year, in his third letter to Collinson, he makes "a few observations on M. Muschenbroek's wonderful bottle". Among these we find: "At the same time that the wire and top of the bottle &c. is electrised positively or plus, the bottom is electrised negatively or minus, in exact proportion: i.e. whatever quantity of electrical fire is thrown in at the top, an equal quantity goes out at the bottom".

In "Additional Papers", sent with a letter to Collinson dated July 29, 1750, Franklin, after describing experiments on the discharging power of points, writes: "may not the knowledge of this power of points be of use to mankind, in preserving houses, churches, ships &c., from the stroke of lightning, by directing us to fix on the highest parts of these edifices, upright rods of iron made sharp as a needle, and gilt to prevent rusting, and from the foot of these rods a wire down the outside of the building into the ground. . . . To determine the question whether the clouds are electrified or not, I would propose an experiment where it may be done conveniently". Then follow directions for carrying out the experiment on some high tower or steeple with pointed iron rod and "a kind of sentry box" to protect the observer.

The experiment suggested by Franklin was first carried out in France, on May 10, 1752, sparks being drawn as a thundercloud passed overhead from an insulated iron rod forty feet high which had been erected by D'Alibard for this purpose at Marly. D'Alibard's delightfully graphic description of the successful outcome of the experiment, read three days later to the Academie Royale des Sciences, was reproduced by Franklin in the fifth edition of his book, and is thus included in the present publication. In a letter to Collinson written in October 1752, he refers to the success of the "Philadelphia experiment" in Europe and describes his kite experiment. His observations were later made with an iron rod passing into his house. By September 1753, he was able to conclude "That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state. . . . So that for the most part, in thunder-strokes, it is the earth that strikes into the clouds, and not the clouds that strike into the earth".

Some of Franklin's experiments must have been designed mainly for the entertainment of himself and his friends; some of these would appear to us now as highly dangerous: "The knocking down of the six men was performed with two of my large jars not fully charged. I laid one end of my discharging rod upon the head of the first; he laid his hand on the head of the second; the second his hand on the head of the third, and so to the last, who held, in his hand, the chain that was connected with the outside of the jars. When they were thus placed, I applied the other end of my rod to the prime-conductor, and they all dropped together."

Franklin's interest in branches of physics other than electricity may be exemplified by a quotation from a letter written in 1752. "I am not satisfied with the doctrine that supposes particles of matter, called light, continually driven off from the sun's surface, with a swiftness so prodigious! . . . May not all the phenomena of light be more conveniently solved, by supposing universal space filled with a subtile elastic fluid, which, when at rest, is not visible, but whose vibrations affect that fine sense in the eye, as those of air do the grosser organs of the ear? We do not, in the case of sound, imagine that any sonorous particles are thrown off from a bell, for instance, and fly in strait lines to the ear; why must we believe that luminous particles leave the sun and proceed to the eye?" It is with something of a shock that we read later in the same letter: "The chymists have analysed sulphur, and find it composed, in certain proportions, of oil, salt, and earth; and having by the analysis, discovered those proportions, they can, of those ingredients, make sulphur".

The quotations which have been given may perhaps serve to give some idea of the fascination of Franklin's book. Mr. Cohen has been able to add much of interest regarding both the book itself and Franklin's helpers and correspondents. In its present convenient and pleasant form "Experiments and Observations on Electricity" is sure of a wide welcome.

C. T. R. Wilson.

NATIONAL VIGOUR AND THE TEMPERATE ZONE

Climate and the Energy of Nations

By S. F. Markham. Pp. 144. (London: Oxford University Press, 1942.) 10*s.* 6*d.* net.

A FEATURE of the human race is the relation of a very constant body temperature to well-being, and that well-being is at its best when the environment is sufficiently lower in temperature to allow of the loss of heat at about the same rate as that at which it is generated, a loss in ensuring which evaporation takes a considerable share. When indoor temperatures are between 60° and 76° F. and relative humidities are between 40 and 70 per cent, men work better than if conditions are outside those limits. Exact figures would vary from country to country according to clothing, to long habituation to heating systems, and temperatures and humidities in general; a certain amount of breeze and of variability of atmosphere is clearly also important. Observations on solar radiation are inadequate, but it seems evident that too much ultra-violet light as well as too little sunlight can be a hindrance to healthy efficiency.

Major S. F. Markham, M.P., makes great play with the 70° F. isotherm, along or near which in the dry regions of the Old World are found the greater civilizations prior to 600 B.C., civilizations which used opportunities to build up populations fairly adequate for defence. The humid areas of that temperature lagged behind. Probably, in this matter, the primary distribution of cereals is important; they are plants of south-west Asiatic origin. Greece and Rome are a little on the cooler side of the 70° F. isotherm and it is probable that they had rather more moisture and perhaps rather lower temperature in the classical period (the early sub-Atlantic phase of climatologists) than now. The additional moisture would be a help, but Markham emphasizes the spread of the hypocaust and of public baths, and, on the other hand, thinks the Greek population was inadequate and too much inclined to limit privilege to citizens. The public baths of Rome, for social and moral reasons, came under Christian condemnation, and the transfer of the capital and aristocracy to Constantinople was another of the multitudinous factors of decline.

The chapter on Islam and the Arabs could have been enriched by consideration of the thought of Ibn Khaldun, much too neglected in western Europe. Islam at any rate advanced in a period that seems to have been a little warmer and more arid than the Classical age in the regions concerned. Just as he refers to the hypocaust in connexion with Classical civilization, so the author emphasizes the development of chimneys and grates in western Europe from the fourteenth century onwards, with the accompaniment, in due course, of windows and wooden floors in draught-proof houses.

It is significant that Markham is deeply impressed by the doctrine that politics is a function of the birth-rate; but while he deals with this statistically, he is in the dark, as are we all, about some of the physiological factors involved alongside the economic influences which bring out all too clearly the influence of the scramble up the social ladder. The ascription of low infant mortality to national vigour and intelligence is perhaps a little overdone when one reflects on the immense possibilities of infection where the summer is really warm. The relationship suggested between climate and general level of life in south-east and north-west England respectively needs a whole book on historical geography for its treatment, but I do recall Sir John Russell's dictum that architecture varies broadly in England and Wales inversely as the rainfall. Perhaps it would have been better to leave out the short reference to the Jews; they are surely far from a "homogeneous race".

If a few reserves have here been indicated, this does not imply any condemnation of a thoughtful and highly suggestive book, which one welcomes all the more because it comes from a man who has been, and is, immersed in public affairs. Darwin's greatest thesis, as is not enough recognized, is that forms of life and their environments are ever acting and reacting on one another and must be studied together. If such studies, from many points of view, could be multiplied, the storms on the military and political horizon would soon diminish; we should understand, where now we so often dogmatize. H. J. FLEURE.

COAL SCIENCE AND TECHNOLOGY

Coke Formation Process and Physico-Chemical Properties of Coals

By Prof. W. Swietosławski. (Polish Institute Series No. 1.) Pp. viii+145+3 plates. (New York: Polish Institute of Arts and Sciences in America, 1942.) n.p.

PROF. W. SWIETOSŁAWSKI is well known in the realms both of pure science and of coal technology, and his new monograph describing the work of the Warsaw Institute of Technology will be welcomed in both fields. The volume appears to be the first publication of the Polish Institute of Arts and Science in America, and as such has an additional appeal in representing a real effort to save the results of scientific work in Poland from the effects of the War.

The researches upon coal of this well-known Polish man of science have been familiar to workers in this field for many years. His scientific papers have been particularly interesting in that the author has always made a special effort throughout to apply to this difficult subject the principles and technique of physical chemistry. It is most gratifying that he should have been spared to continue his work, and particularly that he has been able to preserve enough of the results of his researches as to produce so interesting a monograph. In the translation of his work into English he has been assisted by Prof. Matejczyk and, although in some places the construction may be a little strange, the general result is very clear and understandable. It is unfortunate that the illustrations were not made bolder—some of the graphs are difficult to read and the details of sketches are difficult to follow—but perhaps wartime conditions are responsible.

The preface to the book is by Prof. H. L. Olin of the State University of Iowa, where Prof. Swietosławski has presented his theories on the physical chemical properties of coal in a series of lectures.

The subject-matter of the monograph, although based upon personal researches, has a strong theoretical and speculative bias which is distinctly provocative in pointing out further lines of research not yet fully explored. The author does not give a full bibliography of the subjects on which he touches—it would have been unwise to attempt this in so short a volume—but limits himself to certain of the more widely known researches which bear upon his own theories.

Starting with the first subdivision of coal by Stopes into characteristic and recurrent physical forms, the author devotes the first chapters to discussion of the general physical properties of coal, including sorptive properties, ignition temperatures, and in particular the phenomena associated with the softening of coal under the influence of heat and the agglutination which results in coke formation. All these are discussed in terms of the Institute's researches, and only in a very few cases is reference made to, or comparison with, the work of other authorities; for example, in connexion with ignition temperatures, there is no comparison with the findings of Burrows Moore. Also, there is a tendency to attach too much importance to the interpretation of Foxwell's work. It is an interesting theory regarding the behaviour of coal blends on heating that 'activation' takes place with weakly caking coal, which makes the particles of this coal tend to reject agglomeration with those of the caking coal.

Chapters 5–10 describe in detail the behaviour of coals on heating, beginning with a theoretical study of 'melting phenomena' in individual coals, but particularly with the conditions which obtain when briquetted blends are heated through the stage of plasticity. The theories expounded are based on the examination of coals from different parts of the world and are in general those normally accepted in Great Britain. They are novel in their method of presentation, but the novelty lies more in their expression than in the theories themselves.

It is interesting to read that at Warsaw the Coal Division did not hesitate to translate its researches into larger-scale practice in order that they should not be confused by the effect of scale. This was done particularly in connexion with the carbonization of briquettes and the development of a two-stage carbonization process which involved the erection of special retorts. In principle, the process is not dissimilar from that of Parr's method of coking coal which is deficient in caking power. It is noteworthy, however, that the author has been misled by small-scale phenomena in the briquetting of coal under pressure but without a binder into thinking that preheating alone would liberate a binding material within the coal which would make a strong briquette. Actually this is not the case on a large scale, since larger briquettes retain their heat internally to such an extent that gasification continues after the briquette is made, and the structure of the briquette is ruptured by internal pressure.

The last three chapters of the book are more practical in their outlook and relate mainly to the two-stage process of coking coal, and coal blends, and coal-pitch blends, and to the description of a proposed new process in which the author postulates two stages of heating on the lines of Parr's work.

The book is printed and presented in a pleasing style, and although the sequence seems a little disconnected in places, the arrangement into paragraphs makes for easy reading and gives the author freer scope in his development of the theoretical side of his thesis.

In conclusion, one may express the hope that still more books of this valuable character may follow this first effort by the Polish Institute of Arts and Sciences in America. J. G. KING.

RESTARTING AGRICULTURE IN DEVASTATED EUROPE*

By SIR JOHN RUSSELL, F.R.S.

NEVER before in the whole history of mankind could the people of Europe have had to endure such appalling sufferings as have befallen the occupied countries during the past three years. Poland, Belgium and Greece have suffered especially severely, but the other occupied countries only little less. Even the official rations are inadequate, often supplying only about half to two thirds our standard requirements of calories, and in the case of Jews even less. But the official rations are by no means always forthcoming and the position would be desperate but for the operations of what the Germans call the 'black market'—mainly a device for hoodwinking them. Recent refugees bring acounts of widespread and growing malnutrition and deficiency diseases, children crippled by lack of essential foods, adults suffering from acute forms of tuberculosis, widespread malaria, typhus and other diseases: almost worse still, the populations crushed and made listless by hunger, and rapidly sinking to a condition when they can no longer take much part in rebuilding their shattered lives.

Along with this increasing inability to recover, there has been an appalling destruction of the material means for recovery. The Germans have taken whatever they wanted, and as they are driven out of the different countries they will almost certainly destroy everything possible. Agriculture is largely thrown out of gear: the systems of farming and the rotations are upset. Transport, the twin sister of agriculture, is being utterly disorganized: ships, barges, railway engines, trucks and lorries are being destroyed as quickly as they can be found.

Further, there have been forced deportations of masses of people who will want to be returned to their homes as soon as possible after the war: some eleven or twelve millions are said to be affected.

Modern Germany has certainly achieved the desolation on its borders that Caesar tells us the ancient Germans desired ("De bello Gallico", IV, 3, 2).

A new factor has come into play with which it is by no means easy to deal. During the War, the art of propaganda has been developed to a remarkable degree, and we may be sure that after the War the Germans will make every effort to stir up trouble wherever there are difficulties of recovery. Even after the War of 1914–18, when the methods were crude and undeveloped, trouble was created in eastern Europe; this time the danger will be greater. We must face the fact that the post-war problems will be at least as difficult as those of the War itself.

The first need will be to send in food, and this must be done immediately the Germans are expelled from any region. The need will be so great that the utmost efficiency of distribution will be essential. The Nutrition Committee of the Allied Post-War Requirements Bureau under the chairmanship of Dr. E. F. Penrose, economic adviser at the American Embassy in London, has worked out suited basic rations. Another committee under Dr. Melville Mackenzie is working out methods to cope with the post-war diseases and epidemics.

Steps will be taken to assure supplies of food, but they could not possibly continue indefinitely and it will be imperative to restart the agriculture of Europe at the earliest possible moment in order first to augment and later to replace the efforts of the relief organization.

The numerous agricultural problems involved are dealt with by the Agricultural Committee of the Inter-Allied Post-War Requirements Bureau (of the Ministry of Economic Warfare). This Committee includes representatives of all the occupied countries as well as of the Dominions and the United States, and I have the honour to preside.

The Crops Needed

From what is known of the food conditions in the occupied countries, it seems certain that the most serious shortage is in calories. Until these are available there is no point in supplying more vitamins; indeed, we are told that vitamins without calories might do more harm than good. Immediately possession of the land is obtained it will be necessary, therefore, to sow crops capable of yielding high calorie returns per acre: the easiest and quickest to grow are cereals and potatoes. Pulses will be almost equally necessary to make up deficiencies of protein, for meat is likely to be scarce. The requisite cultivation can be quickly done by tractors if they can be shipped across, but the seed cannot be quickly produced; it must be saved from the crop of the preceding year. Provision of seed has, therefore, to be made beforehand. The position will be so serious that no avoidable risks can be taken; it will be imperative that the seeds sent into any particular region shall, both as to crop and to variety, be suitable to the soils and the climate. These are largely out of our control and we have to adapt ourselves to them.

Now it so happens that in all the occupied countries the Germans have extended the growth of the calorie-producing crops, cereals and potatoes. If the War should end by the autumn of 1943, the harvest of grain and potatoes would, so far as it remained intact, furnish seed for 1944, and much of the difficulty of calorie supply would thenceforward disappear. But if the War continues until the spring of 1944, much of the 1943 harvest will have been eaten or destroyed and the sowing programme will be more complicated. In any event, the supply of cereal and pulse seed must come mainly from the region itself; only in this way can one be sure of getting varieties suited to the conditions. In consequence, the first grain harvest after taking possession will have to be requisitioned by the Government of each country, and a corresponding amount of grain supplied for food. This will simplify enormously the difficulties of transport. Grain for seed must be selected with great care; the germinating capacity must be good; the varieties must be properly chosen and delivered always to the right localities at the right time, and there must be no mixing of varieties *en route*. But for food grains none of these precautions are needed: one variety can serve as well as another, and germinating capacity is unimportant. There will, however, certainly be regions where war operations have led to destruction or consumption of what should have been saved for seed, or where normal supplies are unobtainable; for these some provision from outside sources must be made.

A list of minimum seed requirements has been drawn up, based on the assumption that requisitioning can supply 90 per cent of the seed grain. It includes more than half a million tons of grain seed, mostly wheat and rye—this is only a tenth of the actual requirement—also 11,000 tons of pulse seed, 425,000 tons of potato seed, 20,000 tons of seed for fodder crops, and 27,000 tons of lupins and seradella seed, chiefly for green manuring though some is used for fodder; the weight of vegetable seed required is much smaller though its importance is very great. The total is more than a million tons. The shortages are likely to be very unequal: France is normally an exporter of seed and may lack little beyond wheat and potato seed. Greece, on the other hand, will probably be very short of all seed, of wheat, pulses, potatoes and vegetable and fodder crops. Poland is likely to lack rye, wheat and other cereal and pulse seed, but perhaps not potato or sugar beet seed, though seed of beetroot—so important in Polish cookery—will probably be needed. Czechoslovakia and Jugoslavia will probably lack every kind of seed, and Belgium also. Denmark and the Netherlands may be better off.

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* Royal Institution discourse delivered on March 5.

How can all these demands be met? It is, of course, imperative that varieties be suitable: sources of supply must be selected where the climatic conditions are similar to those of the regions for which the seed is intended. Something can, let us hope, be drawn from Germany, Italy and Hungary, which normally supplied seeds to neighbouring countries. Sweden, a producer of high-quality pedigree cereal seed, could supply Norway, Denmark and Poland; Great Britain can furnish wheat, oat and potato seed to Holland, Belgium, France and parts of Poland, also some spring-sown cereal seeds to Norway, and seeds of vegetables and fodder crops to various countries; North Africa could supply wheat to France and Greece; Turkey could supply wheat, barley and oat seed to Greece.

Potato seed is likely to cause trouble: the only countries with any to spare may be the United Kingdom, perhaps also the Netherlands and Poland, unless the hunger in that tortured country becomes too great. But the storage of potato seed needs care, and disease may spread in the Continental stocks, in which case the United Kingdom becomes the sole reserve.

In all probability it will be necessary to go farther afield. North America can do something, but its climatic regions differ so greatly from those of Europe that only few similar regions can be found for winter crops, though it might do better for spring crops. Eastern Canada could supply autumn wheat seed to Poland, spring oats to Czechoslovakia, peas to Norway, also peas and haricots to Greece. The United States could provide some cereal, fodder crop and pulse seed to Czechoslovakia and Jugoslavia, and perhaps most of the Greek requirements. The Argentine could also supply wheat seed to Greece. There still remain difficult questions of transport; and, of course, the tragedy is that Europe was normally not merely self-sufficing for most seeds, but also had a large export trade.

Livestock Problems

Much more difficult problems will be presented by livestock. Before the War, Europe was comfortably well off for livestock—farm animals, without counting poultry, were nearly as numerous as human beings. In the occupied countries there were in the aggregate 44 million cattle, 34 million sheep, 10 million goats, 27 million pigs, and 10 million horses; 125 million in all for a human population of 137 millions. The numbers of cattle and of pigs generally ran in the same order as the numbers of human population: in most countries, as in the average of all, there was one head of cattle to three or four human beings, and one pig to about five: Denmark had more, having a very large export of dairy produce and bacon, and Greece had less but made up with sheep and goats. The numbers in Great Britain corresponded with these when allowance is made for the fact that we provided only about 40 per cent or less of our food. This similarity of cattle population would not mean similar standards of life. Western European countries imported far more feeding stuffs than Poland and the Balkan countries, and so had a much larger margin for themselves, even after the export demands were satisfied.

The population of horses was not quite in the same order as the human population or the numbers of cattle and pigs. Poland stood highest, partly because of the great importance the Government attached to cavalry, partly also because the peasants much loved horses, and always aspired to be able to drive to church on Sundays in a two-horse and not a one-horse vehicle, with two good horses, not poor ones. Jugoslavia used many horses for transport; Danish farmers loved horses and preferred them to tractors even though the tractors might work more quickly, while Greece used horses for transport and in addition had a considerable number of mules and donkeys.

Cattle are of special importance because they supply three vital necessities: milk, meat and motive power on the farm, but they do not all serve all these purposes. The breeds of cattle in Europe fall into two main groups: the peasant types and the good estate types. The peasant types have been evolved by survival: they are hardy and can live on very rough food and they are fairly resistant to tubercle and to insect-borne diseases. They usually have to serve several purposes: milk, reproduction and work during their active life, and in later life for meat and for leather. These peasant types are very localized: the Polish red cattle, for example, are scarcely to be found outside Poland, though a few, such as the Simonthal, are fairly widespread in Europe; practically none, however, is found outside Europe.

The good-estate types of cattle, on the other hand, are much more specialized, and have been evolved by careful selection, usually for one purpose only, or at most combining only meat and milk production. They give more milk than the peasant types though it may be less rich in butter-fat; the meat types also produce more meat; but they are never used for work. They are less hardy than the peasant sorts, usually more susceptible to tubercle and insect-borne attacks, and more exacting in the matter of food. Certain breeds have spread widely: the Frieslands, for example, are now found all over Europe, but usually on good-sized farms.

Sheep also serve several purposes: milk, reproduction, wool and meat, though even the peasant sorts do not work. But sheep are not closely related to the human population. They occur in high densities in two regions: Great Britain (which is easily first), and south-eastern Europe. The explanation is that sheep fit in very well with intensive cropping systems as adopted in Great Britain; but they are also more suited than other animals to the poor conditions of hill countries.

It is impossible to form any close estimate of the present numbers of livestock, but piecing together the fragmentary information available it appears that by the middle of last year the loss of cattle alone was probably not less than eleven million head —nearly one and a half times the total cattle population of the United Kingdom, or a quarter of the pre-war cattle population. The losses had apparently fallen heaviest on Greece and Poland; so far as could be judged, their numbers were down by about a third or a half. Denmark appeared to have suffered less than most of the others.

It is certain that the position has deteriorated a good deal since the middle of last year. Moreover, these figures, grave as they are, do not tell the whole story. It is the best animals that have gone. Many of the survivors are immature and consequently of less production value; they are not as well-fed as in peace-time and so the yields of milk and of meat have fallen more than is indicated by the fall in numbers. The fall in milk yield has been estimated at 35 per cent; that is, some 3,500 million gallons—more than two and a half times the total production of England and Wales. The loss of sheep has been as great as the loss of cattle over the whole area; that is, about 11 million head; but it has fallen with peculiar harshness on the people of Greece and of Jugoslavia, where sheep were important as the source of milk.

The loss of pigs has been even heavier: by the middle of last year the total numbers in the occupied countries were down by at least 12 million—half the pre-war total—and the fall is certain to be greater now. Denmark, the Netherlands, Belgium and Luxembourg appear to have suffered worst. In most of the occupied countries pigs were the chief source of animal fat; their heavy fall in numbers means a drastic curtailment of calorie supplies.

The reduction in horse population has also been severe owing to heavy requisitioning for the German Army. By the middle of last year, the numbers were estimated down by about three or four million, that is, some 35–40 per cent over the whole occupied region, but the Netherlands had suffered even greater loss, which means, of course, that the working of the farms has become correspondingly more difficult.

Poultry have suffered most of all; by the middle of last year the numbers were only about one quarter the normal, and the position is certainly worse now.

Restoration of the animal population will be slow and laborious, and cannot be attempted until food supplies are in sight: one of the mistakes made after the War of 1914–18 was to send animals before the food was ready for them, and so they simply had to be slaughtered. After food for the animals is assured, milch cattle must be among the first to be increased so as to start making up the very great shortage of milk. Something can be done by supplying more and better food to the surviving animals, for the output of milk increases, up to a point, with the increase in food supply. But this will not suffice. Importation of live animals would be a solution if it were practicable. There may, and we hope there will, be a certain amount of disgorgement from Germany both of pedigree and of utility animals that have been taken from the occupied countries. Hungary may be able to supply one of the peasant breeds, the Simonthal, which is used both in Czechoslovakia and Jugoslavia; Switzerland also may have some to spare and also another peasant breed, Montafon. It is improbable that much of anything movable will remain in Italy after the War, but two Italian breeds, Reggio and Romania, would be useful in Greece. Movements of cattle within the continent of Europe would be easier than importation from overseas. But it seems unlikely that we can reckon on much from Europe; any immediate increase in Europe's cattle population could come only from overseas. Peasant breeds are unobtainable in this way, but good useful Friesians and Ayrshires could be drawn from Canada and the United States; it is not possible to say how many, but even if the figure is put at one million—which would be high—it still replaces only a fraction of the total loss. But there is the further difficulty of transport. A cargo boat of the ordinary 5,000–8,000 ton size could carry some 600 or 700 head of cattle, so that more than 1,500 journeys would be needed to transport our hypothetical million animals.

It seems safe to assume, therefore, that the re-establishment of the herds of milking cattle must come mainly from natural increase. But that is a very slow business: it takes at least two years to produce a new dairy cow, and only half the calves born are females. Cows vary widely in their capacity to yield milk, and it is well known that this quality is derived from the bull. So, from the outset, bulls with a good record of high-yielding daughters should be selected for replenishing the herds: the United Kingdom could supply some of these. Fortunately, the modern method of artificial insemination enables good bulls to be used very economically and to produce numbers of good-yielding calves from animals they have never seen: the bulls can be kept at control stations and the semen distributed by motor-car or by aeroplane over a large number of farms. In view of its importance, courses of instruction in the method have been arranged and attended by veterinarians selected by the different occupied countries, so that they can organize its wide adoption directly they get home. It would be possible to keep the bulls in Great Britain and dispatch the semen by air to the different centres, but it would be more convenient to establish centres in the different countries and to keep carefully selected bulls there. This would, of course, involve importation of the live animals, for which the necessary priority would have to be arranged.

But however carefully it is done, it seems unlikely that the cattle population of Europe can be restored in less than about six years. During the whole of this time, dried milk and other dairy produce will have to be sent into Europe.

The restoration of the horse population will take much longer because the difficulties are greater. Germany could restore any requisitioned horses that survive: the United States could probably supply Percherons if transport was available. Artificial insemination is of much less help than for cattle. Little addition to the total numbers can be expected during the first five years after the War, and full restoration to pre-war numbers may take some fifteen or sixteen years. During the first years it will be imperative to do much cultivation by tractor, though, as every farmer knows, the tractor does not altogether replace the horse for general farm work.

Under good conditions the sheep population should recover more rapidly than the cattle, but in poor and hard conditions such as will certainly obtain in south-eastern Europe, recovery is bound to be slow; it has been estimated as at least nine years.

Pigs, however, multiply much more quickly; a good sow can produce and rear ten or fifteen piglets in a year; in spite of the drastic reduction we need not assume more than two years as the time needed for restoration to pre-war numbers. Not only are pigs by far the most prolific of all the larger farm animals, but they are also the most economical in their conversion of food into meat and fat, both of which will be urgently needed in Europe after the War. The case for the pig would be irresistible but for the unfortunate circumstance that, of all the animals on the farm, pigs are most like ourselves in food requirements: they take grain, potatoes, skim milk, fish and meat; they thus stand in sharp contrast with sheep and cattle, which take grass, straw and other coarse fodders of no use to us. So when human food is scarce pigs are not encouraged, or at least not beyond what can be fed on waste materials unfit for human consumption.

The same difficulty arises in the case of poultry, which are even more prolific than pigs, for under good management one hen may produce large numbers of chickens in a year. But again the food required is largely the same as for human beings, and so in spite of their value as producers of high-class protein, and tragically enough, in spite of the great need of high-class protein, it will not be possible greatly to encourage poultry-keeping, at any rate until the human food position becomes clearer. It will, however, be essential to furnish the peasants with some pigs and poultry as early as possible, so as to ensure speedy re-establishment of their holdings and full utilization of any waste material.

Certain administrative actions will facilitate matters. Immediately the Germans are expelled from any region it will be necessary strictly to control the slaughter of animals and to forbid the slaughter of female animals suitable for breeding and milking, and some at least of the working bullocks; if possible, however, bringing in some compensating amount of meat. The distribution of feeding stuffs will need to be regulated, and the veterinary services must be put into operation.

The reduction of livestock has greatly decreased the production of farmyard manure, and this has been intensified by the shortage of fertilizers, especially of phosphates. Immediately the Governments secure possession of their lands, this difficult problem of restoring fertility will need attention. Lupins and seradella can in certain regions be grown as green manure if seed is obtainable. The supply of fertilizers is likely to present many difficult problems because of their localized distribution. Phosphates are obtained mostly from North Africa, and potash from Germany and Alsace; nitrogen-fixing factories are more widespread, but their present products are not very suitable as fertilizers.

Lastly there remains the extremely difficult problem of re-settling on the land the enormous number of people—estimated at some 11–12 millions—taken or deported from the occupied countries. This, however, I do not propose to discuss.

The immediate starting up of agriculture is only a small part of the task. Agriculture is a long-term business; the farmer must know not only what he is to grow this year but also what the year after, and the year after that. So it is necessary to think ahead beyond the 'first-aid period' and to decide what is to be the object of the agriculture. In the first year it must produce calories. But is that to continue permanently? There are two purposes at which European agriculture might aim: highest standard of nutrition for the people; or maximum degree of self-sufficiency for the country or group of countries. Although we did not deliberately aim at it, we in the United Kingdom achieved the highest standard of nutrition in Europe but the lowest degree of self-sufficiency. Germany, on the other hand, achieved a high standard of self-sufficiency but a considerably lower level of nutrition. The British dietary was rich and varied and required large areas of land for its production: on English yields no less than 1·6 acres, of which beef alone accounted for nearly half; but much of our food was imported from countries of lower yield, so that something more than two acres was needed to feed the average Englishman. But the German dietary was much simpler: it contained less meat, less butter and sugar, fewer eggs, less fruit; all these desirable and luscious things were replaced by potatoes, of which the Germans consumed twice as much as we did in Great Britain. Their dietary required less land for its production, and one acre almost sufficed to feed the average German. As they were less densely packed on the land than we are, they were able to produce nearly 85 per cent of their food.

The necessities of war are driving us on to the German dietary: our average consumption of meat —including all sources—is now estimated at about 70 lb. per head per annum—half our pre-war consumption: so that the area of land required for our present dietary is considerably less than it was.

In pre-war times we imported into Great Britain more than 60 per cent of our food, but the import was not evenly distributed. British farmers concentrated on the most lucrative products; they produced the whole of our milk and our potatoes, some 70 per cent or more of our eggs, poultry and malting barley, 50 per cent of all our meat—a much higher proportion of the best-quality meat—but only 25 per cent of our wheat and only 10 per cent of our butter, these being much less lucrative in British conditions. Our pre-war feeding arrangements gave a higher standard of living not only to the people in the towns but also to the farmers and farm workers than the German system. The annual net value of the output of the British farm workers was, before the War, put at £200, while that of the German farm worker was only £70; the average weekly wage for the British worker was 30–36*s*. and was rising, while that of the German was 23*s*. German farm workers had to work at least as hard as ours, but their products were less lucrative and so their remuneration was lower.

The choice before Europe after the War will be self-sufficiency, or high standards of nutrition. In a self-sufficing Europe the inhabitants restrict themselves to what they can produce and go without the rest, or accept instead products for which one must use the German name *Ersatz* because the English language does not possess a sufficiently disagreeable word. Already the Germans have re-organized agriculture in the occupied countries on this basis, aiming at calories rather than protective foods. Grain and potatoes have replaced the more specialized and lucrative live-stock products and fruit of the western countries, Holland, Belgium and Denmark, bringing great distress on their farmers. If this were continued after the War it would impoverish not only Europe but the primary producers also. Even prior to the War there was considerable over-production of calories in relation to the demand, and this had led to such pitiful results as the burning of wheat in some regions, while others, for example Italy, were suffering from shortages which a policy of self-sufficiency forbade them to satisfy. Representatives of the occupied countries now in Great Britain have expressed their views at conferences of the British Association, Chatham House and elsewhere; they reject the idea of a self-sufficing Europe; they do not want this low standard of life and they recognize that it leads to chaos, even to war. They prefer to aim at the highest possible standard of nutrition: the phrase 'freedom from want' has reverberated through Europe, and aroused among its stricken people hopes and desires that we, who have never suffered as they, can only dimly apprehend. But this policy of abundance means that each region must produce the foods it can grow best, and exchange its products freely with other regions: there is no place for restrictions on trade in food. It is, in fact, the old policy of 'peace and plenty' that Bright and Cobden advocated so long ago.

If this were adopted, the farmers of Europe would aim at producing high-quality protein and protective foods, taking calorie production in their stride but not aiming specifically at it. They would import from the great primary producing regions of the world the additional calories and protein needed for themselves and their animals. After the first year of calorie production their efforts would be diverted to these more profitable activities.

Another decision must also be taken. What is to be the pattern of country life in Europe after the War? Before the War, most of Europe's agricultural land was in small holdings, though there were large estates in Poland, Hungary and elsewhere. Russia, on the other hand, has gone in for large farms. In commerce and industry the large unit has obvious advantages and has in fact eliminated many of the smaller producers. It has been urged that we now have the chance of reorganizing European agriculture and should do it on the basis of large farms, not of small ones. The analogy between agriculture and industry cannot be pushed far because of the fundamental distinction that the processes of industry are wholly under control and can be worked to a programme, while those of agriculture are not: there must on each farm be daily adaptation of programme to weather and other conditions. We have had some very successful large farms, but it has not infrequently happened that when the leading spirit has departed, they break up again into smaller units. Prof. A. W. Ashby recently analysed the returns from a number of farms and showed that the small farms gave a greater return per acre and per £100 expended, employed more men per 100 acres and paid more in wages than the large ones. Actually the case is not as simple as it looks, and the figures need a good deal of qualification: probably the safest generalization is that small farms are best for gross production; large farms for net production.

There would, of course, be a strong case for large farms if Europe were adopting the New Order and going in widely for grain production, this being well adapted to big-scale operations and to heavy mechanization. But the production of protective foods, involving as it does numbers of animals of various kinds, is well suited to the small farm.

A combination of the two systems, large and small, has been worked out in the collective farms of the U.S.S.R. The grain and large cultures are done on the large scale; the farm may be 2,000 or more acres in size and the workers share the produce—or, rather, what is left of it after Government and other dues are paid, the sharing being in accordance with the work done. But in addition, each member of the collective has his own piece of land and his own animals: actually a considerable number of the farm animals of the U.S.S.R. belong to the peasants as their own individual property. The conditions favour the system: the large rolling plains of the south are eminently suited to grain production; the large areas of land not yet utilized prevent any possibility of population pressure on the land, while the high density of population on the farms affords scope for working the individual holdings and tending the privately owned livestock. These conditions, however, do not obtain in any of the European countries.

Representatives of the occupied countries have stated very clearly that they do not want large farms, whether privately owned, State owned, or collective. They admit that some of their large farms have been very productive; some of the Polish estates, for example, have been not only efficient producers but also their homes have been delightful centres of Polish life and culture. But the majority prefer the smaller holdings. So agrarian reform has for some years been busy breaking up these big estates into small peasant holdings. Even where the management has thereby become less efficient, the social advantages are considered to outweigh the economic disadvantages. There is a big peasant population for which provision must be made. Industry is not far enough advanced to absorb large numbers, and emigration is probably out of the question. Also, there is very real land hunger; the innate desire to own a piece of land—usually a particular piece of land. In eastern Europe this has even become a line of political cleavage, and strong Peasant Parties exist in Poland, Czechoslovakia, Jugoslavia and elsewhere.

The history of collectivization in the U.S.S.R. is a clear warning against forcing on the peasants any scheme of amalgamation that they do not like. For the first few years of collectivization the numbers of animals fell drastically: there were several causes, but one was the dislike of some of the peasants for the new scheme. Then came the compromise in 1935 and 1936, which allowed the peasants their own bit of land and their own animals, and the numbers of animals began to go up: unfortunately the War came before one could see the full results. We could not, however, tolerate the possibility of peasant disturbances in Europe after this War, and so we must accept the decision to re-establish small peasant farms.

But they need not reproduce the technical and economic weaknesses of the old ones. All the countries concerned have set up agricultural research, advisory and educational services, and the small farmer can be given all the advantages of better varieties of crops, more efficient fertilizers, more economical rations for his livestock, better health services for animals and for crops. Further, agricultural engineers are now turning their attention to the design and manufacture of small implements suitable for small farms that will not only lighten the work but also enable it to be done much more quickly, so avoiding many of the wastes and losses resulting from slower methods. Electricity and the internal combustion engine have the great advantage that they are little less economical for a small job than for a large one. The small farmer need be neither inefficient nor a drudge; he can be technically competent and provided with labour-saving implements.

In the past, the financing of the farm and the buying and selling of the produce have been major difficulties in the life of the peasant. The money-lender and the middleman—whether they were one and the same or different individuals—have often made the peasants' life a burden. Marketing of produce has always been a wasteful procedure; the bulky material has been sold to a middleman and the small stuff taken by the women to market and there sold for whatever it would fetch—a time-consuming operation which, however, was very sociable and clearly enjoyed by the women. These and many other difficulties can be got over by co-operation, and I am firmly of opinion that the only hope of successful establishment of peasant holdings lies in the development of a strong co-operative movement. The Horace Plunkett Foundation in Great Britain is a mine of information on the subject; Denmark can show actual working models, and indeed most of the occupied countries have some experience with it. Co-operative societies can not only buy for the peasant, finance useful operations and warn severely against useless ones; they can also take over the peasants' products, grade and process them, pack them properly and sell them through expert salesmen who know the best markets and can obtain the highest prices. They can thus assure to the peasant the maximum return for his labour.

The experience of Denmark shows how well co-operation can flourish in an educated community. Education is absolutely essential; not simply technical education, but, what is even more important, the moral education that teaches a man to pull his weight and play the game; to accept his full share of responsibility for the community, doing the right thing because it is right and not simply because he fears he might otherwise be caught. In addition to agricultural schools, the Danes early set up 'Folk High Schools' to give this moral training to awaken intelligence and idealism; they were Christian, national institutions and they helped to form an industrious, honest, competent farming community composed of extremely hard-working people, producing commodities of high quality and enjoying a standard of life that was the envy of most of Europe. The Danish small farm expresses the ideal at which many of the leaders of the occupied countries are looking with longing eyes, hoping that when their long night of agony is ended there may dawn a brighter day for themselves and their children.

We, too, shall have our part to play. In his extremely interesting "Life" of Marlborough, Mr. Churchill shows how in the seventeenth and eighteenth centuries Great Britain twice saved Europe by heading the Allied Nations against a power seeking to dominate the whole Continent. Twice the war was won, but twice the peace was lost because we withdrew too soon. Modern history has made the lesson more emphatic; nations cannot live in isolation. On all grounds—economic, political and moral—we must in the reconstruction of Europe render all possible help and continue to play our part in the years of peace to which the nations are looking forward with such ardent longing.

EDUCATION IN THE BRITISH ARMY

By Lieut. T. H. HAWKINS

TWO and a half years ago the British Army education scheme as we know it to-day was officially launched as the "greatest experiment in adult education that has been undertaken in this country". During its period of growth the scheme has come in for a great deal of publicity, adverse and otherwise. A review of its progress may be of use in helping to assess its value as an indication of the way in which adult education is likely to develop in Great Britain in future years.

In the months preceding the outbreak of war the Workers Educational Association and the Y.M.C.A., in consultation with the Board of Education, had convinced the War Office that educational opportunities of a general character, apart from any classes and lectures which form part of military training, should be provided for the young militiamen during their six months compulsory training. To meet the potential demands for lecturers, the universities enlarged their extra-mural boards *ad hoc* by adding to the representation of the voluntary bodies concerned and began to lay plans for their active participation in the scheme. War came, and these *ad hoc* committees were dispersed.

But the demand for education could not be ignored. In the early part of 1940, the initiative of the various voluntary organizations connected with adult education led to a widely representative conference at which the setting up of a Central Advisory Council for Adult Education in H.M. Forces was decided upon. In due course the universities, local education authorities and voluntary organizations for adult education appointed members, the three Services nominating observer representatives. The vice-chancellors of universities and principals of university colleges were invited to call conferences in their areas, for the purpose of establishing regional committees through which the Central Advisory Council might work. Thus the civilian educational resources were mobilized and placed at the disposal of the Services.

Later a committee met under Sir Robert Haining to consider means whereby the Army's own resources for lecturing and teaching, as well as organization and administration, might be established. (Here it may be noted that, at the outbreak of war, the personnel of the Army Educational Corps of the Regular Army were transferred to operational roles, for the discharge of which in France they were officially commended by Lord Gort in his dispatches.) The report of the Haining Committee appeared in August 1940, and it is from that date that the scheme as it now exists may be said to have had its birth.

A directorate of Army education was established, the first director being Mr. F. W. D. Bendall, who was seconded from the Board of Education. The Army Education Corps was gradually strengthened, both by the return of its regular peace-time personnel and by the inclusion of new members from the war-time Army.

The objects of the scheme can be briefly stated: (1) maintaining the men and women of the Army in good heart and morale by the provision of educational activities which could be pursued in their off-duty hours; (2) improving the military efficiency of the fighting services directly by the sharpening of mental faculties through constant stimulation and indirectly by the elimination of boredom; (3) the provision of incentives and opportunities so that men and women should be given every chance of pursuing their peacetime occupations in preparation for their return to civilian life.

Those who had been appointed to implement this scheme were now charged with making themselves worthy of it. The first task lay in promoting publicity, and, from the beginning, the co-operation of the troops was invited by asking them to submit posters to illustrate the facilities offered by the Army education authorities.

By February 1941 the provision of educational facilities for men and women in the Forces was going steadily ahead, although many soldiers in communications to the Press still complained that in their units educational activities were non-existent. But in spite of lectures postponed and courses interrupted by operational duties, even at that time an average of some four thousand lectures and three thousand classes were taking place each month. Most of the lectures and classes were taken by civilians, but in many cases Service men and women with specialist qualifications gave their support.

It must be realized that the successful operation of an educational programme under war conditions was not an easy task. Apart from the difficulties of administration, organization and accommodation, many lecturers found to their great surprise that lecturing to troop audiences was not quite the same as to, say, a W.E.A. audience. Men and women in the Forces form a representative sample of the entire population, and their attitudes to education were as varied as one would expect from such a heterogeneous group. For many soldiers 'education' was but a means of sending them to school again with the implication that they were 'dunces'. Some wore the smile of incredulity; others were afraid of being made to look small and had the marked fear and distrust of budding educationists, which is such a characteristic 'hang-over' of their school-days for so many. Further, a fair proportion of the soldiers are quite inarticulate, while others regard any attempts at discussion as personal disparagements of their characters. (May not one concrete aim of education in the future be to train men in argument so that, although differing violently from their fellows, they part on friendly terms? This is probably even more necessary for women than men.)

Despite all the difficulties, however, the war-time scheme gained momentum. In order to make the fullest use of unit resources and to train regimental instructors, short courses primarily designed to give basic training in citizenship, knowledge in international affairs and in the methods of instruction, and the running of discussion groups were instituted. For units stationed in towns and villages, the accommodation problems were eased by civilian co-operation, arrangements being made whereby small classes were able to meet in private houses on certain evenings. In some cases buildings were requisitioned and converted into Army study clubs and were used for diverse activities. Most of the educational activities, however, were still being carried out in the uncongenial surroundings of barrack-rooms. To meet this situation the Army Council authorized the provision of quiet rooms for educational studies, and to-day the appearance of, and educational activity in, a unit 'quiet room' is often a guide to the military efficiency of the unit.

With the development of 'academic' pursuits other activities began to emerge. Soon, all the practical classes which one associates with a modern technical college were in operation in some unit or other. These were either conducted in adjacent technical institutes or, in some cases, at neighbouring works when the employees were off duty. (One engineering firm held very successful classes in motor engineering for troops on Sundays.) Practical classes have grown apace and now the 'hobbies and handicrafts room' is one of the show-places in many units.

Music for the Forces has been greeted with enthusiasm similar to that which has revealed itself all over Great Britain during the last four years. Each Command has a full-time E.N.S.A. music adviser; the growth of music clubs in units has been such that these advisers must be rated as among the most hard-worked people in the Army.

So the story unfolds. Interest in the fine arts has been nourished and is bearing sound fruit. Fullest possible use has been made of visual education, and touring pictorial exhibitions have become a common feature of the educational scheme.

Nor have the Army authorities been negligent in developing new methods in education: in many units where facilities for seeing newspapers and hearing broadcast news are poor, 'wall newspapers' have been produced and have become a most effective method of stimulating and maintaining interest in current events as well as providing information about local affairs. From these 'wall newspapers' to the provision of separate information rooms was not a far flight, and these have now become well-established features of Army education.

To meet the demands of troops in units that are constantly on the move, correspondence courses were introduced. These consist of vocational courses, covering nearly all the examinations for the recognized professions, and postal study courses, including those subjects which might conveniently be described as catering for the academic examinations, including pre-matriculation. The initial problems that were raised by the inauguration of such a tremendous scheme have now been ironed out, and many of the more serious students admit their indebtedness to the correspondence scheme. Between September 1941 and March 1943 there were 22,000 enrolments for vocational correspondence courses and 14,300 for postal study courses. In passing, it should be mentioned that this is the only educational activity for which a small fee is charged, the sum of 10*s.* being charged in order to exclude those who were likely to fall at the sight of the first hurdle.

The work of the Army Education Corps in hospitals deserves special notice. One soldier in hospital means that the fighting efficiency of his unit and of his country has been reduced. In co-operation with the Royal Army Medical Corps, the Army Education Corps has promoted educational activities in military hospitals designed to return the man as quickly as possible to his military duties. Occupational therapy remained the charge of the medical authorities, while the educational instructors were given the task of promoting educational pursuits of a miscellaneous nature which would provide the patient with diversional occupations and speed his recovery and return to duty. These miscellaneous activities are too numerous to mention, but it can be confidently asserted that Army education has made an important contribution to adult education in its hospital scheme. When the full story is told, it is incumbent on all adult educationists to make themselves fully conversant with it.

From the foregoing it can be seen that the programme for education in the war-time Army is very comprehensive and has been tackled with ardour and enthusiasm despite desperately discouraging circumstances. Yet until September 1941 the men charged with operating this programme were keenly aware that they were achieving only a small part of their objective. The voluntary nature of the scheme meant that the educational facilities available were being used only by those people who would normally be engaged in some form of educational pursuit in their peace-time occupations, estimated at about 20 per cent of the whole. The other 80 per cent remained the hard core who displayed little interest and yet included most of the men for whom some form of education was greatly to be desired and who stood in greatest need.

To meet this need a measure of compulsion was necessary. This was first provided in September 1941, when the Army Bureau of Current Affairs was introduced. An official order was issued asking commanding officers to make arrangements for all the personnel on their establishments to be given instruction in current events for one hour each week *during training hours*. This hour was introduced in order that soldiers might keep abreast of current affairs and so know the purpose behind their duty. In order to surmount the difficulty of shortage of specialist instructors, it was decided that the scheme should be administered by regimental officers. Each officer was charged with carrying out the Army Bureau of Current Affairs hour in his particular platoon or section. As an aid the Army Bureau of Current Affairs issues him with a brief each week on which to base his talk. These briefs are of two kinds and appear alternately. One, called "Current Affairs", aims at providing a background of knowledge against which current events can be assessed and understood. The other, "War", aims at providing a picture for the soldier of what is happening in the various theatres of war. The most important issue raised by the introduction of the Army Bureau of Current Affairs, however, was the expressed statement that each talk should form the basis of discussion and that all soldiers should be given opportunities to air their opinions freely, however far-fetched and unsubstantiated they might be. There is little need to dwell on the success of this scheme. It is enough to say that the Army Bureau of Current Affairs to-day is recognized as an integral part of Army life. Its establishment has undoubtedly assisted in promoting better relations between all ranks as well as in the maintenance of morale by disseminating facts about the high purpose of our cause.

It must be made clear that the introduction of the Army Bureau of Current Affairs did not mean the discontinuance of other educational activities. Far from it. These continued to flourish and were considerably extended by the compulsory nature of the Bureau. By last autumn Army education had made such progress that the Army Council agreed to introduce compulsion for other educational work. Accordingly a scheme was drawn up designed to be carried out during the period November 1942–February 1943. At least three hours per week were to be allotted from training or working hours to education. It was suggested that three hours should be used in the following manner:

(*a*) One period to be devoted to educating the man as a soldier, for example, by providing instruction in map-reading, message writing, etc.

(*b*) One period to the education of the man as an individual. In this period men were to be encouraged to pursue subjects of their own choosing.

(*c*) The other period to be concerned with the education of the man as a citizen. This period is devoted to talks and discussions on the British mode of life, its institutions and methods of government, the British Commonwealth of Nations and British relations with the other members of the United Nations. To cover the citizenship period, monthly directives were issued and met with a very favourable reception.

This scheme has now come to an end and, where commanding officers have lent their support, has achieved considerable success. The citizenship period, in particular, has contributed so much to Army life that the War Office has decided that it shall continue, based on other topics, over the next few months at least.

"The greatest experiment in adult education" is a fitting description of such a gigantic scheme. But even this is only a prelude to the tremendous educational operations which must inevitably be introduced when victory comes and we are faced with the problems of demobilization. We can never be over-prepared. The place of science in this scheme was outlined in the columns of NATURE of August 16, 1942, p. 173, and a letter from Dr. Basil Yeaxlee in NATURE of September 6, 1942, p. 288. It is hoped to discuss it more fully at a later date.

INDIGENOUS MALARIA IN GREAT BRITAIN

By Sir ARTHUR MacNALTY, K.C.B.

DR. WILLARD C. RAPPLEYE, of Columbia University, has recently issued a warning that after the War the United States will probably be faced with the risk of epidemics of malaria, brought about by the return of malarial patients who have served in the Middle East and other theatres of war where the disease prevails.

In the United States, malaria has progressively diminished in extent and severity during the past eighty years. From New England, where it once prevailed extensively, it has gradually disappeared, and in Philadelphia and along the valleys of the Delaware and Schuylkill Rivers, formerly hot-beds of malaria, the disease has become much more restricted. In Baltimore a few cases occur in the autumn, but the majority of the patients come from outlying districts and one or two of the inlets of Chesapeake Bay. Throughout the Southern States there are many regions in which malaria prevails; but here, too, the disease has diminished in prevalence and intensity. In temperate regions, like the central Atlantic States, there are only a few cases in the spring and a large number of cases in the autumn. In the Northwestern States malaria is almost unknown. It is rare on the Pacific coast, and in the region of the Great Lakes it prevails only in the Lake Erie and Lake St. Clair regions.

The introduction of fresh foci of infection from abroad would obviously be inimical to this favourable picture, and a similar danger to that foreshadowed by Dr. Rappleye faced Great Britain in the War of

1914–18. The total number of locally contracted cases notified or discovered by special inquiry after September 1917 amounted to 330, of which 38 were in the Navy, 224 in the Army and 68 in the civil population. It appears that 231 of these cases were contracted in 1917 and 99 in 1918. One interesting observation was the detection in 1918 of some patients in whom an infection contracted in the previous autumn had remained 'latent' during the winter. This was previously noted in England during the early years of last century[1].

The sources of infection were multiple. In the Army, the origin of practically all the locally contracted cases was attributable to the presence in their immediate neighbourhood of relapsing cases of malaria among soldiers returned from eastern war areas, especially Salonika. The same source was usually responsible for cases among naval ratings and civilians.

At certain English ports during 1917 and 1918, a potential source of infection of considerable importance was provided by the crews and passengers of transports and merchant ships which had called at Dakar, Sierra Leone and other ports on the west coast of Africa. During the War, malaria was exceptionally prevalent and severe in these ports. In 1917 more than five hundred cases of malignant tertian malaria were introduced into England on ships from the West Coast and the Cameroons. Fortunately, the Anopheles of Great Britain do not act as efficient carriers of tropical malignant malaria[2]. In addition, it was found in some cases that malaria seemed attributable to infection, not from military foci, but from civilian patients in their immediate neighbourhood and, in a few instances, to civilian cases which had occurred before troops began to return from Salonika. Such an indigenous origin was ascribed to a considerable local spread of malaria in Kent. It was stated, for example, that so late as 1865–70 "nearly everyone in Queenborough suffered from ague" and that occasional cases had occurred every year since that time. The clinical symptoms of these Kentish cases were less severe than those of cases which were traced to an origin from military foci.

Malaria was formerly prevalent in Great Britain. In Sydenham's time agues were both frequent and fatal. James I and Oliver Cromwell both died of ague contracted in London. In the eighteenth century malaria was endemic; almost exclusively, along the eastern coast; in parts of Kent, Essex, Cambridgeshire, Norfolk, Suffolk and the East Riding of Yorkshire. Malaria prevailed then also in the eastern part of Scotland, especially in East Lothian, where the reapers at harvest-time were always attacked by it. In the nineteenth century the disease diminished greatly in Great Britain owing to the drainage of the fens and marshlands, which were brought under cultivation.

The presence of these endemic foci of malaria is not generally recognized by the medical profession and the public. They do, however, exist, and investigation by medical officers of the Ministry of Health in the intervening period between the last and the present War indicates that the distribution of indigenous malaria in England is about the same as that already described for the eighteenth century. Sinton and Shute advance sufficient reasons for believing that the density of *Anopheles maculipennis* offers the most likely explanation of this topographical distribution[3].

Indigenous malaria, which usually takes the benign tertian form, is not common; the symptoms are usually mild, and instances of this type escape recognition unless malaria forms the subject of intensive investigation as in war-time. In peace-time there are always a certain number of imported cases in persons who have originally acquired malaria abroad; there were 354 such cases with 30 deaths in 1938, as contrasted with two indigenous cases in the same year. Such cases help, no doubt, to keep the strain of the benign tertian parasite persistent in England.

Although there are four species of Anophelines in Great Britain, only one species, *Anopheles maculipennis*, has so far been proved to be a carrier of malaria: this species is made up of a number of varieties or sub-species, which, while as yet indistinguishable in the adult stage, can be differentiated on the character of their eggs. Two varieties occur in England—one (var. *messeæ*) breeds in the fresh water of inland ponds and streams, the other (var. *atroparvus*) mainly in brackish water in coastal areas, but may occur in smaller numbers in inland waters. The latter variety is the chief carrier of malaria in Great Britain.

In peace-time the problem of the transmission of malaria by mosquitoes is seldom one of magnitude in Great Britain, and most measures against mosquitoes are usually undertaken in order to reduce their biting propensities. In war-time the problem naturally assumes a more serious aspect.

The successful policy pursued towards the end of the War of 1914–18 was based primarily on the early detection of all cases and carriers, followed by thorough treatment, protection from mosquitoes, and special supervision and control. On the military side this policy was adopted throughout Great Britain, and it was supplemented in a few areas by local anti-mosquito measures directed against breeding-places. In view of these arrangements by the Army authorities, on the civil side exceptional precautionary measures, including notification, were at first limited to a few localities, which were selected either because cases of indigenous malaria had already occurred in them, or because they were places in which a considerable concentration of possible human malaria carriers coincided with an abundance of Anophelines. This limitation was justified in 1918, for only three cases of indigenous origin occurred outside the selected localities.

After the armistice of 1918, with demobilization, the possibility of local spread of malaria had to be watched. Accordingly the Local Government Board in January 1919 in a General Order (Public Health (Pneumonia, Malaria, Dysentery, etc.) Regulations, 1919) (afterwards amended by the Public Health (Infectious Diseases) Regulations, 1927) included clauses which imposed on local authorities and their officers throughout the country certain new powers and duties in regard to malaria prevention. Malaria cases, including those of demobilized ex-Service men, and others who have contracted infection abroad, are made notifiable in England and Wales. The medical officer of health in any district is empowered to investigate risks of local spread of malaria and to take any necessary action to prevent it. For example, when a man suffering from malaria occupies a house which is infested by Anophelines, at the cost of the local authority mosquito netting can be provided, suitable quinine treatment given, and proper advice afforded as to the precautions needed against the spread of infection. The medical officer of health, after confirming the diagnosis and the local origin of the case, should send the name and address to the Ministry of Health with all available particulars. All practical assistance is given by expert officers of the department to medical officers of health and medical practitioners in any case in which indigenous malaria is suspected. Blood films and other specialized examinations are arranged for.

The malarial work of the Ministry of Health was afterwards augmented by the provision of a malarial laboratory and centre at Horton Mental Hospital, Epsom, on the suggestion of Lieut.-Colonel S. P. James. The primary object of this unit was to provide treatment for general paralysis of the insane by induced malaria as initiated by Wagner-Jauregg of Vienna. The Board of Control, the London County Council and the authorities of Horton Hospital are closely associated with the Ministry in this work. The laboratory portion of the unit was under the control of Colonel James and afterwards under that of Lieut.-Colonel J. A. Sinton, assisted by Mr. P. G. Shute and laboratory assistants, while Dr. W. D. Nicol, medical superintendent of Horton Hospital, is in charge of the clinical side of the work. The unit further acts as a centre for the study and identification of mosquito nuisances in Great Britain, and a number of important papers and reports on the subject have been published by James, Nicol and Shute. Mr. Shute has paid visits to many districts in Great Britain and has advised on the control of Anophelines.

With all this administrative and scientific machinery to hand, it can be confidently anticipated that the Ministry of Health will safeguard the population of Great Britain against the risks of an increase of indigenous malaria after the present War as successfully as it did after the War of 1914–18.

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[1] Reports and Papers on Malaria contracted in England in 1918. Reps. to L.G.B. (N.S. No. 123.) (London: H.M. Stationery Office, 1919.) See also P. G. Shute: "Protracted Incubation Periods in Indigenous Cases of Malaria in England", *J. Trop. Med. and Hyg.* (July 15, 1939).

[2] Shute, P. G., "Failure to Infect English Specimens of *Anopheles maculipennis* var. *atroparvus* with Certain Strains of *Plasmodium falciparum* of Tropical Origin", *J. Trop. Med. and Hyg.* (July 1, 1940).

[3] Sinton, J. A., and Shute, P. G., "Memorandum on Measures for the Control of Mosquito Nuisances in Great Britain". Memo. 238/Med. Ministry of Health. Revised Edn. (London: H.M. Stationery Office, 1943.)

OBITUARIES

Major Leonard Darwin

With the death of Leonard Darwin on March 26, in the ninety-fourth year of his age, has passed the last of the five sons born to Charles Darwin. Taking the five sons in the order of their birth, William, the eldest, showed no aptitude for science; the second, George, the third, Francis, and the fifth, Horace, were gifted with creative faculties of a high order, all three becoming fellows of the Royal Society. Leonard, who came fourth in the series (he was born at Down House on January 15, 1850), although he did much to further the cause of science, manifested none of those creative gifts which had been so liberally bestowed on his father and three brothers. Yet, in physical appearance, especially in later years when he grew a beard, in his attitude to life, and in the disposition of his mind, he bore a closer resemblance to his father than did any of his brothers. He had his father's honesty of expression, openness of mind, charitable disposition, subjugation of self, an excess of candour ("d——d candour" his father named it on a certain occasion when irritated by unfair criticism) and also his father's happy sense of humour. He was completely devoid of personal ambition. There were not a few, however, who were ambitious on his behalf and felt that his services to science should have been recognized by election to the Royal Society. The University of Cambridge rightly bestowed on him an honorary doctorate of science.

In 1868, at the age of eighteen, Leonard entered Woolwich, being second on the list at the entrance examination, a success which made his father exclaim: "I shall burst with pleasure at Leonard's success!" He served with the Royal Engineers for twenty years, retiring in 1890 on attaining his majority. During this time he was a member of two expeditions sent to observe the transit of Venus—in New Zealand (1874) and in Queensland (1882)—but for the greater part of his service he was engaged in the routine of office work or of acting as instructor at various staff colleges.

On retiring from the Army, Leonard Darwin entered public life, being elected Liberal Unionist member for the Lichfield Division of Staffordshire in the Anti-Home Rule election of 1892. In the election which followed three years later, he lost his seat and eventually retired from politics. Perhaps no one was less fitted for the rough and tumble of political life than Leonard Darwin. He was completely devoid of the "Party spirit". He looked on politics as the art of applying science to the problems of government. We see the trend of his mind at this time, in two publications which he issued at the close of his brief political career—on "Bimetallism" (1898), and on "Municipal Trading" (1903). He served (1913–20) as chairman of Bedford College for Women.

His real work in life came to him in 1911 on the death of his distinguished cousin, Sir Francis Galton. Galton had founded the Eugenics Society in 1908 (by the way, it is just sixty years since Galton coined the term 'eugenics'), and served as its honorary president until his death in 1911. Thereupon Leonard Darwin fathered the Eugenics Society, and continued to devote all his energies to promoting its welfare until 1929, when the late Sir Bernard Mallet took over the presidency, while Darwin continued to serve the Society as its honorary president. His attitude towards eugenics is given in detail in a book published in 1926, entitled "Need for Eugenic Reform".

In 1928 he withdrew from London, making his home at Cripps Corner, on the western outskirts of Ashdown Forest. He was twice married, first to Elizabeth Fraser, who died in 1898, and later to his cousin, Charlotte Mildred Langton, who died at Cripps Corner in 1940. There were no children by either marriage. Those who had the privilege of visiting at Cripps Corner carried away unforgettable memories of human life at its best. Arthur Keith.

Mr. H. D. Taylor

Harold Dennis Taylor, a quiet man of simple tastes, varied interests, and wide knowledge, died on February 26, aged eighty-one. Probably best known as the inventor of the Cooke lens, he achieved much else that would have brought him fame.

Taylor was educated at St. Peter's School, York, and began to train as an architect, but was offered employment at the works of Thomas Cooke and Sons, scientific and surveying instrument makers, on account of his scientific interests. His inventive ability soon showed itself, for within a short time of entering his new occupation he took out the first of a long series of patents. In a few years he had become optical manager and soon afterwards a director of the Company.

Fine optical instruments may be the outcome of artistic or of scientific work. The great men of the past—Thomas Cooke himself, for one—took pride in their rightful description as artists. To-day we live in a scientific period. Dennis Taylor belonged to both—he combined in the happiest way both the artistic and the scientific ways of working. When his professional career began there were no books which could be used as guides by the young optician, and Taylor set out to build up a body of theoretical knowledge. He took as his model Airy's work and its development by Coddington. The task extended over many years, but valuable results were reached by the way. For example, by close study of his formulæ, Taylor decided that better photographic lenses could be made by using three separated achromatic doublets. His method apparently consisted in making up an instrument to a specification based on an approximate theory, and observing the character and magnitude of the outstanding defects. Modifications for removing these defects were made on the same theoretical basis, and this process was continued until he was satisfied with the result. To this extent the theory of the original form of Cooke lens preceded practice. The later form composed of three single lenses was evolved by a process in which practice came before theory. Of the Cooke lens itself it is sufficient to say that it is the foundation of many most successful later types, including some of the most recent. Of all existing designs it is probably the one which an artistically minded designer would most like to have produced.

In his theoretical work, having derived complete formulæ of the first two approximations, Taylor set out to construct a complete system of the third and if possible of the fourth orders. In this he was only partially successful, for the methods he employed were probably inadequate for so difficult a task. The results of his work were published in 1906 under the title "A System of Applied Optics". There can be little doubt that it was the most important book on this subject that had appeared in English for nearly a hundred years, and Taylor showed remarkable magnanimity, which unfortunately has rarely been imitated, in making his work available to other lens designers.

It is only possible to mention one or two of Taylor's many other activities. In 1892 he produced his 'photo-visual' objective, which marked a great advance in telescope construction, and was largely used for mapping the heavens. A valuable little book, "The Adjustment and Testing of Telescopic Objectives", appeared in 1901, and in 1904 he discovered a process for increasing the light transmission of lenses—the forerunner of the modern 'blooming' process.

His work was most appropriately recognized by the award of the Duddell Medal of the Physical Society and of the Progress Medal of the Royal Photographic Society.

Following his retirement from active business, Dennis Taylor went to live in the beautiful village of Coxwold, beloved by him and his ancestors. He leaves a widow, two sons and a daughter. His younger son is the optical manager of Cooke, Troughton and Simms, Ltd., the successor of T. Cooke and Sons.

T. SMITH.

NEWS and VIEWS

Association for Scientific Photography

PHOTOGRAPHY has firmly established itself as an essential scientific instrument; and a wider knowledge of the uses to which it can be put would do much to assist in the solution of the problems confronting workers in science and industry. Many workers either have difficulty in obtaining information concerning photographic techniques, or are unaware of their existence. For these reasons, a group representing widely different fields of science and industry believe that a new organization designed to meet their special photographic requirements would be of considerable value. The Association for Scientific Photography has therefore been formed, the objects of which can be briefly stated as follows:

(1) To promote the advancement of photography n all branches of science, technology and medicine, and to assist its members in the application of photographic methods to the solution of particular problems.

(2) To afford its members opportunities for interchanging opinions and discussing matters connected with photographic techniques. Meetings will be arranged from time to time at which papers and short communications will be delivered and discussed, together with practical demonstrations of apparatus and methods. It is the intention of the Association o publish the proceedings in a journal as soon as conditions permit.

(3) To establish an information bureau containing, so far as is possible, full particulars of the activities of members, and in suitable cases the existence and whereabouts of specialized photographic apparatus. These data will be used by the Association for the benefit of its members as a pool from which information may be drawn on the varied applications of photography to research, industry and teaching.

(4) To endeavour to obtain for members information on practically any photographic problem which may arise in the prosecution of scientific work.

(5) To foster the production of sub-standard films for research and teaching purposes, and to give information on methods of production and presentation of films of scientific interest.

The field covered by the Association must, of necessity, be a wide one in order to carry out its functions. It will embrace photographic processes of all kinds, such as radiography, colour photography, photomicrography, high-speed photography and, in particular, sub-standard kinematography in all its branches. Membership of the Association is open to any person actively engaged or interested in the use of kinematography or photography as a scientific instrument. An announcement of the first meeting will appear in due course. The committee of the Association consists of the following: Prof. J. Yule Bogue (chairman), professor of physiology, Royal

Veterinary College; S. Boyle, Photographic Section, I.C.I. Research Dept.; Miss K. C. Clark, radiologist, Ilford, Ltd.; G. A. Jones, Research Dept., Kodak, Ltd.; E. H. Le Mon, Tanar (British) Corporation; Dr. H. Mandiwall, dental surgeon; C. D. Reyersbach, of W. Watson and Son, Ltd.; G. H. Sewell (treasurer), Ministry of Supply; R. McV. Weston (organizing secretary), Ministry of Supply. Further information can be obtained from the organizing secretary, R. McV. Weston, whose present address is Houndwood, Farley, Salisbury, Wilts.

Committee on Nutrition Surveys

Investigation on certain aspects of nutrition is at present handicapped by lack of co-operation. In view of the importance, at the present time, of a thorough knowledge of the state of nutrition in Great Britain, the Nutrition Society has accordingly set up a Committee on Nutrition Surveys, with Sir Joseph Barcroft as chairman; the terms of reference are the co-ordination of nutrition surveys dependent on (*a*) clinical, physiological and biochemical examinations of human subjects, (*b*) examinations of food budgets, and (*c*) chemical analyses of food and meals (including collective meals). It will put investigators in touch with others who are working on the same lines or would co-operate; it will supply information, recommend methods and make periodical summaries of the results of investigations. The Committee has the support of the Ministries of Health and of Food and co-operation of the Services. Prof. J. R. Marrack has been appointed as a director serving under the Committee. All who are engaged on or undertaking investigations covered by the terms of reference are invited to communicate with Prof. Marrack at the London Hospital, Whitechapel, E.1.

Soviet Medical and Scientific Men

N. Egorov writes: The Medical Section of the Allunion Society for Cultural Relations with Foreign Countries is strengthening the scientific bonds of Soviet medical circles with medical institutions, organizations and scientific workers in other countries. At the last plenary meeting of this Section it was announced that the Section has received many requests from medical institutes, societies and individual scientific men wishing to establish or revive connexions broken off by the War. The Section has taken steps to make this possible. It has done much to forward abroad books and articles written by members of medical institutes in the U.S.S.R. and to send greetings from Soviet scientific men to various journals and to workers in the field of medicine. The Section has also dealt with numerous requests from Russian men of science for books and articles not available in Moscow to be sent from Great Britain and the United States. To make widely known the work of Soviet medical institutes, clinics and scientific workers, the Section regularly publishes the *Medical Chronicle*, which reflects current war-time problems of Soviet medicine. It has also selected for foreign countries scientific films on various medical subjects such as "Physiology and Morphology of Bacteria", "Microscopic Study of Living Tissue" and "Physiology and Pathology of the Heart", in the production of which eminent Soviet men of science took part. Nicholas Semashko stated that the Section receives publications issued by the Medical Society of America and a War-time Medical Review from Great Britain published by the Anglo-Soviet Committee of Medicine. All this literature is handed over to the Central Medical Library and to libraries of various medical institutes, so that wide use can be made of it. Addresses of members of the Section on the report of Prof. Nicholas Semashko discussed the strengthening of scientific ties with medical organizations and individuals abroad. The Section aims at facilitating the exchange of experience in the medical sciences and increased collaboration of Soviet, British and American medical workers. Nicholas Burdenko, of the Academy of Sciences of the U.S.S.R., was presented at the meeting with a complete set of surgical instruments sent to him from Philadelphia.

Science and Reconstruction in Canada

In a paper, "Science and Reconstruction in Canada", read at a joint session of the Royal Society of Canada at the University of Toronto on May 29, 1942, which has now been reprinted, Prof. J. K. Robertson points out that in the industrial and social fields, the federal and provincial governments in Canada have already shown that they are aware of some of the urgent problems which will have to be met when victory comes. Referring to specific ways in which the services of the scientific worker are essential, Prof. Robertson instanced the increased use of Canada's coal deposits, particularly methods of utilizing coal at its source; and the depletion of existing ore reserves and the desirability of discovering new sources of both old and new materials and developing new processes of extraction, for example, for magnesium. After speaking of the utilization of waste materials, such as natural gas, as a field for research, he referred to schemes intended to promote decentralization or dispersal of industry, the industrial utilization of farm products, and a general improvement in living conditions and in methods of farm operation through more available and cheaper power. Although in part economic questions, the practicability of such schemes depends largely on the work of the man of science. Again, in regard to the farm as a source of raw materials, the position of the plastics industry requires consideration in relation to agriculture. The soya bean, for example, is the raw material, not only for oil but also for a new cloth and for a plastic adhesive for plywood, while such materials as straw and cereal refuse might conceivably also find uses in the plastics industry.

Finally, Prof. Robertson considered the relation of science to society, and suggested that science should be more than the handmaid of the State. Science should recognize that it has a social mission and accept a wider responsibility than in the past. Problems involving co-ordination of the sciences, a wiser application of new discoveries, and quicker and better State action following official reports would be helped greatly by the establishment of a small scientific advisory council to act in a liaison capacity between science and government. It would also be of great value in the consideration of the larger social issues which will have to be faced in the post-war years. Scientific men, collectively and individually, must also do more to educate the general public about the nature of their investigations. They gladly recognize that man does not live by bread alone, but they claim that a type of training which insists on honest inquiry, impartial judgment and a fearless facing of all facts is not altogether remote from the other tradition which puts the emphasis on truth, beauty and goodness.

Peoples of the Philippines

The war in the Philippines has not been forgotten, nor has the courageous part played by the Filipinos alongside their American allies. But the average individual knows little about the geography of the Philippines, and less about the folk who inhabit them. To remedy this state of affairs, the Smithsonian Institution has produced War Background Studies No. 4, "Peoples of the Philippines", by Herbert W. Krieger; it contains 86 pages of interesting print, a number of well-chosen illustrations, and an extensive bibliography. An account of the topography, climate, and kindred subjects is given, but most of the work is devoted to a description of the people. As might be expected, they are for the most part very mixed in origin and are the result of more than one culture contact in the past. This is clearly apparent in the realm of religion, where it appears that many pagan Indonesian ideas and superstitions still persist, although the large majority of the inhabitants are Christians. The material culture of some of the more primitive tribes includes knives of various kinds, bows and arrows, and the blow gun. The darts in use with the latter are often poisoned, there resulting an exceedingly effective weapon for killing small game silently. Various types of houses are illustrated, and a description of the language given. But anyone wanting to know more about these islands and their interesting inhabitants, who surely will have a not unimportant part to play in the post-war world in the Pacific, should read for himself about the islands and their inhabitants.

New Farm Crops for Australia

Australia possesses three main stations for testing the agricultural and horticultural suitability of various kinds of plants from other regions for Australian conditions. Pamphlet No. 114 of the Commonwealth of Australia Council for Scientific and Industrial Research (314 Albert Street, East Melbourne, Victoria), by A. McTaggart and T. B. Paltridge, gives details of some of the useful and outstanding species tested at the Lawes (Queensland) station, which has a sub-tropical climate. Among the outstanding introductions is *Stylosanthes guianensis*, which appears to be capable of assuming the agricultural role of lucerne (*Medicago sativa*) under tropical conditions. The variety *polia* of *M. sativa* is also suitable. Two kinds of cocksfoot grass, *Dactylis glomerata* var. *hispanica*, from southern France, and a strain from Algeria, also appear among the outstanding introductions. Details of the yield of *Paspalum scrobiculatum*, *Urochloa pullulans*, *Panicum maximum* and Rhodes grass are given, and indicate higher potential yields than are obtained from present grassland. *Phaseolus lathyroides*, a shrubby legume from tropical regions, has been found to behave as a slender twining plant when associated with grasses, and indicates the necessity for imagination and insight when testing the suitability of new plants.

Research on Cancer

Among the numerous laboratories and institutions engaged in cancer research throughout the British Empire, none has a higher reputation than the Royal Cancer Hospital and its associated Chester Beatty Research Institute. We therefore welcome the republication in one attractive volume of a selection of papers which issued from these laboratories during the period 1935–39 (London: Royal Cancer Hospital (Free). 16*s*.). These had previously been published in many different journals in Britain and the United States, and their assembly will prove of great convenience to many workers in this field. Greatest importance will probably be attached to the series of papers by Prof. E. L. Kennaway and his colleagues on the synthesis and properties of carcinogenic compounds, which probably embodies the most notable contribution to cancer research during the last decade. Other valuable papers deal with the physical aspects of low-voltage, high-voltage and radium therapy and with topics concerning the pathology of cancers. The Institution is to be congratulated on this fine record of its work.

Venereal Disease Control

In an address delivered at the Third Pennsylvania Health Institute (*Med. Rec.*, New York, Jan. 1943) Colonel Edgar Erskine Hume states that, during the War of 1914–18, General Pershing issued orders to the American Expeditionary Forces on the following lines: (*a*) education in sex hygiene and the nature and prevention of venereal diseases; (*b*) prophylaxis; (*c*) physical examinations; (*d*) repression of prostitution; (*e*) reporting sources of infection with dispensary treatment of infected civilians where possible; (*f*) court martial of men who contracted venereal disease; and (*g*) treatment of venereal disease at the front, thereby removing any possible temptation of men to become infected, and so get sent to the base. Although Pershing's programme did much good and was far in advance of that of any other country, seven million days of service were lost and a total of 338,746 soldiers were treated for venereal disease. In spite of the large number of cases, venereal disease is less prevalent in the army than in corresponding civil life. The rate of venereal disease in the United States Army has been reduced from 175 per 1,000 in 1904 to about 34 or 36, and has never been above 50 since 1926.

Murine Typhus in Bogotá

In a preliminary note (*Bol. Of. San. Panam.*, 21, 1090; 1942) on this subject, Dr. Luis Patino-Camargo, director of the National Institute of Epidemiology and Medical Research at Bogotá, states that to date eight strains of the typhus rickettsia type have been found and classified in Colomba. He maintains that all these forms may be reduced to epidemic typhus, murine typhus and Tobia spotted fever. In three different places in Bogotá cases of typhus have occurred apparently caused by an endemic virus carried by fleas and maintained in wild rats. The writer, therefore, concludes that an intensive attack should be undertaken in Bogotá against these animals.

Standardization of Overhead Power Supply Lines

H. Willott Taylor and K. L. May, in a paper entitled "Standardization in Great Britain of Single-Circuit Overhead Lines up to 33 kV.", presented recently in London before the Institution of Electrical Engineers, consider that standardization can be done in a rational manner which will avoid any likelihood of stultification of new ideas; the preparation of suitable standard designs of overhead lines could be undertaken by a standing committee of the British

Standards Institution. Some of the Electricity Commissioners' regulations are reviewed with particular reference to their latest modifications for light lines. Details are given of the design evolved by the British Electrical and Allied Industries Research Association for light high-voltage lines up to 22 kV. which is now being considered by the B.S.I. With slight modifications, this design can be adaptable for 33-kV. working and also for heavier conductors. An alternative design, employing wood 'H' poles and suspension insulators, is suggested for special cases. A low-voltage design is also detailed and recommended.

The design covered by the draft B.S. specification is suggested for general adoption in Great Britain for high-voltage lines up to 22 kV. with conductors of 0·04 sq. in. or less. With minor modifications this design could also be used for the larger sizes of conductors and for 33-kV. working. To meet special local conditions, an 'H' pole suspension type of line could be provided. Standard designs for insulators, clamps, joints, stay rods, etc., should be prepared and be obtainable from any of the usual suppliers. A joint meeting between the supply undertakers and the railway companies should be arranged to consider whether modifications to the present standard conditions for railway crossings are not justifiable in the light of up-to-date experience. A discussion between supply undertakers and Post Office authorities is desirable, to determine whether the present somewhat onerous conditions required by the latter could not be modified considerably, and greater use made of 'joint user' poles.

Trade Unionism and Scientific Workers

UNDER the title "British Trade Unionism", the Association of Scientific Workers has issued a short study course for scientific workers prepared by Dr. J. Kuczynski and a study group of the Central London Branch, which was formed early in 1942, on trade union history with special reference to the development of non-manual organization and the history of the Association of Scientific Workers in particular. The booklet is in five chapters: why trade unions were formed in Great Britain and how they were developed; how scientific workers came to found a trade union; a short history of the Trades Union Congress; the structure of the Trades Union Congress; and the story of the Association of Scientific Workers. Of these the second and last show a certain lack of proportion and perspective. Within the limits imposed by pamphlet size, however, the first and the last three chapters give a concise—but biased, not to say prejudiced—account of the development of trade unionism in Great Britain and the association of professional defence organizations of scientific workers with this movement. Limitations of size, however, cannot excuse the paucity of the bibliography and the absence of bibliographic detail. The writers would do well to remember that history and propaganda are ill consorts.

Department of Scientific and Industrial Research: Appointments

THE Lord President of the Council has appointed Dr. A. Parker to be director of fuel research in the Department of Scientific and Industrial Research. Dr. Parker joined the staff of the Department of Scientific and Industrial Research in 1928 as assistant director of water pollution research. He had previously been engaged for some ten years on research for the gas industry, including full-scale experimental work, as senior research chemist to the Joint Committee of the University of Leeds and the Institution of Gas Engineers. Since the outbreak of War he has been acting-director of water pollution research. He has served for many years on the Council of the Institution of Chemical Engineers and has been a vice-president of the Institution.

Mr. E. Barnard has been appointed principal assistant secretary in the Department of Scientific and Industrial Research. Mr. Barnard joined the administrative staff of the Department in 1919, and has been director of food investigation since 1934.

Mr. R. O'F. Oakley and Mr. G. R. D. Hogg have been appointed assistant secretaries in the Department. Mr. Oakley joined the administrative staff of the Department in 1920, after previous Government service in the Patent Office. He became assistant to the director of fuel research in 1938, but since 1940 his services have been lent to the Ministry of Home Security as deputy chief adviser, Research and Experiments Department. Mr. Hogg joined the administrative staff of the Department in 1920, and was appointed establishment officer in the Department on the outbreak of the War.

Announcements

SIR HENRY DALE, president of the Royal Society and director of the Royal Institution, has been awarded the Harben Gold Medal by the Royal Institute of Public Health and Hygiene.

MR. P. I. DEE, University lecturer in physics in the University of Cambridge, has been appointed to the chair of natural philosophy in the University of Glasgow as from October 1 next. The chair becomes vacant by the retirement under the age limit of Prof. E. Taylor Jones.

THE Pilgrim Trust has purchased the residue of Newton's library which was being offered for sale (see NATURE, April 10, p. 416). Scientific workers and other students will welcome the news that this unique historical material will be preserved in Great Britain.

THE following have been elected officers of the Royal Astronomical Society for the ensuing year: *President*, Prof. E. A. Milne, Rouse Ball professor of mathematics, University of Oxford; *Treasurer:* Mr. J. H. Reynolds; *Secretaries:* Dr. H. R. Hulme, chief assistant, Royal Observatory, Greenwich; and Mr. D. H. Sadler, superintendent of the "Nautical Almanac"; *Foreign Secretary:* Sir Arthur Eddington, Plumian professor of astronomy, Cambridge; *Council:* Miss M. G. Adam, chief assistant (astronomy), University Observatory, Oxford; Dr. E. C. Bullard, Smithson research fellow of the Royal Society; Prof. J. A. Carroll, professor of natural philosophy, University of Aberdeen; Dr. T. G. Cowling, lecturer in mathematics, University of Manchester; Mr. F. J. Hargreaves; Dr. A. Hunter; Captain W. N. McClean; Dr. G. C. McVittie, reader in mathematics, University of London (King's College); Prof. L. M. Milne-Thomson, professor of mathematics, Royal Naval College, Greenwich; Mr. H. W. Newton; Mr. F. J. Sellers; and Mr. W. M. Witchell.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Terminology in the Geological Sciences

DR. R. H. RASTALL[1] probably does not intend us to take too seriously his criticisms of geological and palæontological terminology, but his statement that "popular geology is being killed by pedantry" cannot be allowed to pass unchallenged. It is not very clear from his article whether he refers to the increasing refinement of modern geological studies or to the attempts to incorporate such details in elementary courses for students. He comments on the "enormous number of zones and sub-zones now recognized in several systems", but as he does not appear to question the validity of the subdivisions it is not clear what procedure he would suggest. That many such tables of zones are unsuitable for presentation to elementary students is accepted by most teachers of the subject, but these tables reflect an extension of knowledge, and Dr. Rastall agrees that against this "nothing can be said". Geology would indeed be a strange science if all its more recent advances could be incorporated directly into elementary courses.

Problems of terminology are particularly acute in geology, as in biology, but they also arise in any attempt at a simple or popular presentation of other sciences. In geology much can still be done with a minimum of unfamiliar terms, but in my experience, when a beginner's interest has once been aroused, he terminology is not a deterrent to more serious study. In fact, amateur geologists have themselves provided a good share of the zones and sub-zones and of other names which Dr. Rastall thinks are a deterrent to the popularization of geology. The readiness with which the necessary terminology of any subject is acquired by an interested amateur is seen among gardeners.

Many will join with Dr. Rastall in regretting that few field geologists are now able to name the fossils hey collect. Although many field workers do in fact earn to recognize the most significant species occurring in their areas, it is not surprising that others find it simpler to leave most of this work to pecialists, in view of the increase in our knowledge of fossil faunas and the degree of precision in identification which field workers now find essential for the elucidation of many structures of importance (for xample, in the search for oil and coal).

The species problem as it affects the palæontologist has been much discussed recently, and those concerned with systematic work on fossils are alive to the difficulties which arise in the application of the Linnean system and of the International Rules f Nomenclature. But much as we may hope to see revised system of nomenclature with an evolutionary asis, our knowledge is far too incomplete for this o be attempted in more than a few groups. Even o, whether we note our fossils under new names or y formulæ, original papers recording them will continue to be difficult to understand by those who have ot made some effort to master the new terminology. The loss of familiar generic names such as Pecten, Terebratula and Rhynchonella from many lists is noted by Dr. Rastall, but I do not think that this need affect the elementary student. Glasgow students in their first year use the genera with their original wide significance, but if they continue to study the subject they seem to find no difficulty in replacing them by such terms as Terebratulid and Rhynchonellid, and in realizing that there is nothing inappropriate in the rather loose nomenclature of the elementary course.

So far as my experience is concerned, as a teacher in three universities and an examiner in four or five others, when elementary classes are considered, I do not believe that palæontological and stratigraphical terminology has in any way diminished the attraction of the subject. That any decline in numbers of geology students is largely to be attributed to changes in entrance requirements and in regulations for degrees and to the introduction of the Higher School Certificate in England is shown by the fact that at Glasgow (where these changes have not operated) there are even now almost two hundred students of geology. When students, in school or university, have the opportunity to learn geology, its attraction is felt as keenly as ever.

Finally, I would repeat the words which the distinguished American palæontologist Hyatt felt it necessary to use so early as 1867, "there is nothing to be dreaded in new names except by those who strive to get the animal kingdom by heart".

A. E. TRUEMAN.

University of Glasgow.

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[1] NATURE, 151, 294 (1943).

WHILE one sympathizes with Dr. Rastall in his attempt to keep up to date in all branches of geological science[1], it should be pointed out that he has neglected three points in his survey of the problem.

(1) It is open to the field worker, now as ever, to name his own fossils. It is as easy to use the names of yesteryear as it ever was. The field worker, an essentially practical person, sends his fossils to the expert because precise determinations are useful to him, not from any superstitious respect for nomenclatorial 'mumbo-jumbo'. That a more refined nomenclature affords increased stratigraphical precision can scarcely be urged as an argument against such refinement.

(2) There is a fallacy in the contrast of petrological and palæontological nomenclature. Terms such as 'granite' and 'basalt' correspond to such terms as 'brachiopod' and 'graptolite'. The description of a particular granite would include a long chemical analysis, careful description of the mineral assemblage present and of its interrelation, and would then, and only then, correspond to the species of the palæontologist. If granites identical in all these respects occurred at many widespread points on the earth's surface, and had been described at different times, in different languages, by workers of all degrees of competence, then Dr. Rastall would find that definite laws, or rules of nomenclature, would be necessary in petrology, and the resulting names would appear strange and formidable to the outsider.

(3) No student need learn all the complicated nomenclature of palæontology. Using again the petrological analogy, a student could well be expected to learn and recognize a granite, and various types of this rock, but no one in his senses would hand him a specimen from, say, South America, and expect him to learn its chemical formula and most minute characteristics. Emphasis must be on characters common to all granites or to great groups among them. Similarly, in the teaching of palæontology, emphasis should be and is placed on the make-up and structure of classes, orders and families within

the great phyla, not on the recognition and retention, parrot-like, of minute differences between species. Often it will be found that such families practically correspond with the genera such as Ostrea, Pecten and Rhynchonella, for which Dr. Rastall has such a nostalgic sentiment, and here he is fighting the air, for teachers of palæontology have long since complied with the spirit of his plea.

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[1] Nature, 151, 294 (1943).

On a minor point the two foregoing letters are contradictory. Dr. Wood says a field geologist can name his own fossils, while Prof. Trueman admits that he cannot. Only a palæontologist can decide this.

Dr. Wood's remarks on granite are really irrelevant. If, instead of basalt and granite, names chosen as known to everybody, I had written, for example, "umptekite Ramsay" and "jocupirangite Derby", his argument would have no bearing on the subject.

I can assure Prof. Trueman that my article was meant to be taken very seriously. I do not suggest that the decline of geology as an academic subject and a popular hobby is due solely to pedantry, but generally to the crushing burden of a complicated nomenclature. As an example of pedantry, which is near akin to priggishness, I instanced the habit of quoting the authority for a fossil every time. If space allowed, I could quote a scathing paragraph on this subject written in 1899 by Prof. Charles Lapworth. Only the last sentence can be given here. "Such vain repetition can only add unnecessarily to the amount of the printer's bills, and increase what is amply sufficient for scientific purposes, the vanity of the species maker himself."

The main object of my article was to protest against the incessant multiplication of new *generic* names founded usually on minute differences and obscuring genetic relationships. This I regard as obscurantist and anti-evolutionary. A French physicist has well written, "Nature is a workshop, not a museum", and the object of research should be to discover her methods and her tools. But palæontology has now become a chaotic mass of disconnected names. To paraphrase a famous saying of Henri Poincaré, a card index is not a science, any more than a dictionary is a language.

R. H. Rastall.

Mode of Chemical Action of X-Rays on a Non-Aqueous Solution

Dale, Meredith and Tweedie[1] have recently shown that the mode of action of X-rays on certain dissolved enzymes, similarly to the action on aqueous ferrosulphate[2] and on aqueous hæmoglobin[3], is in agreement with the 'indirect action' mechanism[3] as opposed to the 'direct hit' mechanism. It appears that the ionizing radiation activates the water and that the activation products in turn react with the enzyme. Hydrogen peroxide has previously been identified as one product of the irradiation of water[4].

It may be interesting to compare the results of Dale *et al.* with those of some (unpublished) experiments in non-aqueous solution, which were carried out at the Institute of Physical Chemistry, University of Berlin, during 1931–32, but could not be completed owing to the political changes in Germany. The object was to show whether what is now called the 'direct hit' mechanism applies to solutions of X-ray sensitive substances in non-sensitive solvents, that is, in solvents which, when used alone, are not activated. In such solvents radiation energy would no be stored. 'Direct hit' reactions should be of the first order both with regard to X-ray dosage and to concentration ; on the other hand, the rates of reactions of the type described by Dale *et al.* can in extreme cases be independent of concentration.

First an attempt was made to measure the decomposition in organic solvents of benzophenone diazide $(C_6H_5)_2C(N_3)_2$, a substance previously studied as a solid[5]. Unfortunately, the nitrogen liberated in the solution could not be measured with any accuracy owing to supersaturation. However, success was achieved with a solution of ammonium persulphate in practically anhydrous glycerine. The solution was contained in a cylindrical glass tube 2 cm. long and 1 cm. wide (volume very nearly 1·5 c.c.) which was mounted in a fixed position about 2 cm. from the window of the X-ray tube. The rays were produced in a gas tube with molybdenum anticathode, filtered through zirconium oxide and aluminium, and had an effective wave-length of 0·8 A. They entered the glass vessel through its extremely thin concave base[6] The concentrations before and after irradiation were determined iodometrically. Glycerine by itself was not affected. In a preliminary run it was ascertained that at constant concentration the yield is proportional to dosage, if irradiation was interrupted before the concentration decreased markedly.

In the accompanying table concentrations are given in mgm./c.c. and dosages in arbitrary relative units each unit representing 1 m-amp.-hour ; voltage (40 kV.) was kept constant. The variation with increasing concentration of the absorbing and scattering properties of the solutions will not materially change the energy available.

Concentration	Dosage	Mgm. decomposed	Percentage decreases per unit dosage
109	67	2·5	0·023
150	51	2·5	0·022
190	87	3·3	0·013
263	70	6·8	0·025
381	68	7·8	0·020
382	81	9·8	0·021
Solid	>100	0	0

The constancy of the last column shows that in th range investigated the yield per dosage unit is proportional to concentration ; that is, the reaction i of the first order with regard to persulphate concentration. The lack of effect on the solid seems t show that the decomposition proceeds in severa stages and that a medium is required to prevent reformation of ammonium persulphate from a primary product.

While the results of Fricke and of Dale *et a* indicate that in aqueous tissues yields are generally less than proportional to concentration, the abov experiment demonstrates that this need not be s in non-aqueous (for example, lipoidal) tissue.

This work was undertaken on the initiative o Prof. P. Günther, who devoted much attention to i

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Quenching of Fluorescence by Nitric Oxide

It is known that the fluorescence of many hydrocarbons and particularly of the polycyclic hydrocarbons in solution is often strongly quenched by molecular oxygen[1,2]. We have now investigated several other gases with regard to their quenching effect towards polycyclic hydrocarbons.

Carbon monoxide and nitrous oxide are without any measurable effect. On the other hand, nitric oxide, which in many respects resembles molecular oxygen, shows a strong quenching of the fluorescence of, for example, anthracene, benzpyrene or methylcholanthrene in various solvents, such as hexane, ethanol, etc. The effectiveness of a particular solvent again depends primarily on the solubility of nitric oxide in it. As in the case of oxygen, this quenching effect is completely reversible if the nitric oxide is replaced, for example, by pure nitrogen. This can again be taken as some evidence for a reversible oxidation and reduction system in these cases[2].

Just as in the case of oxygen, where it is possible to obtain the photochemical formation of a peroxide under suitable conditions, prolonged ultra-violet irradiation of these hydrocarbon solutions in an atmosphere of nitric oxide probably leads to the formation of what may be termed nitroxides $(C_nH_m)NO$ analogous to the peroxides $(C_nH_m)O_2$.

It seems that these nitroxides are even less stable than the peroxides and cannot usually be separated as such, but we have obtained several crystalline nitrogen-containing compounds, as a result of the photochemical reaction, which are presumably products of secondary irreversible changes of the primarily formed nitroxides.

A full account will be published elsewhere.

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March 22.

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Determination of the Water Content of Wood and other Substances by means of Ternary Azeotropic Mixtures

It is peculiarly difficult to dry certain substances and to determine the water in them because (*a*) if liquids they may form inconvenient mixtures of constant boiling point (azeotropic) with water, (*b*) if solids they may retain water of crystallization, form syrups, or be susceptible to oxidation, or (*c*) their structure and colloidal state may hinder the loss of water, as in wood, peat, etc. One well-known method is to distil after adding a liquid immiscible with water; the distillate settles into two layers and the volume of water is measured.

Young and Fortey[1] used fractional distillation for quantitative analysis of liquid mixtures and obtained anhydrous ethyl alcohol by distillation with benzene. All water is removed in the ternary azeotropic mixture which boils at 64·85°, and has 74·1 per cent benzene, 18·5 alcohol and 7·4 water. The alcohol benzene binary boils at 68·24°. With this procedure Atkins and Wilson[2] obtained anhydrous solids, lævulose, maltose and starch, suspended in benzene.

The method can be used for quantitative determination of water in a solid, since the anhydrous alcohol abstracts the water which distils over in the ternary. Conditions laid down by Young[3] for liquid mixtures should be observed, and accuracy checked using known weights of water. Disappearance of turbidity in the condenser indicates the complete removal of this addition. Accuracy is increased by the fact that the ternary mixture weighs more than thirteen times as much as the water in it. Other ternary mixtures contain even less water. Hill[4] obtained one boiling at 61·8° and consisting of carbon tetrachloride 86·3, alcohol 10·3 and water 3·4 per cent; the corresponding binary boils at 65·2. Atkins[5] found one boiling at 65·7 with carbon tetrachloride 76·9, methyl-ethyl-ketone 20·1 and water 3·0 per cent. The binary boils at 73·8°, giving good separation. Both ternaries are less inflammable than the one with benzene. They are also more sensitive, since they weigh, respectively, more than twenty-nine and thirty-three times as much as their water content. An eight-section Young evaporator still head was used throughout.

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March 31.

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Onset of Fibrillation in Denervated Muscle

Recent studies of the phenomenon of fibrillation in denervated muscle have shown that it is subject to considerable variation. Since this phenomenon is becoming of increasing importance in the diagnosis and prognosis of nerve injuries, we feel that the following observations should be recorded.

We have found that, in laboratory mammals and man, fibrillation invariably occurs provided the denervated muscle is maintained at body temperature. We have found, also, that the time of onset of fibrillation following denervation of voluntary muscles varies according to the size of the mammal. In the mouse, fibrillation commences 3½ days after nerve section; in the rat 4½ days; in the rabbit (small) 6 days, (large) 8 days; in the monkey (*Mac. mulatta*, small adult) 8 days, and in man (11 stone) 18 days. These differences may be related to the metabolic level, for we have observed that the onset in thyroidectomized rabbits is delayed until the fourteenth day. In the light of these observations, muscles in man have been investigated by means of electromyography following peripheral nerve injuries. It has been found possible to record fibrillation following denervation, partial or complete, if the lower motor neurone is divided anywhere between the anterior horn cell and the periphery. It is easy to distinguish the action potentials of motor unit activity from those of fibrillation, and this distinction is proving of definite use in clinical diagnosis and prognosis[3].

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B. FEINSTEIN.
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March 27.

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[2] Denny-Brown, D., and Pennybacker, J., *Brain*, 61, 311 (1938).

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Science, Common Sense and Decency

WHEN a man of science deals with subjects outside his special sphere the result is always interesting, but not always illustrative of the caution and rigour of the scientific method. It is rather startling to find Dr. Irving Langmuir declaring (see NATURE, March 6) that "Reason is too slow and difficult", and adding that when we do not possess the necessary data or when we find a problem too complex for the methods of reasoning we must use "common sense, judgment and experience" and should not underrate the importance of intuition. Surely common sense (carefully controlled), judgment and experience are factors in the process of reasoning ? As for intuition, the example given by Dr. Langmuir is this : "In almost every problem which I have succeeded in solving, even those that have involved days or months of work, the final solution has come to my mind in a fraction of a second by a process which is not consciously one of reasoning". Can this culmination of days and months of concentration be properly described as intuition ? Or are we to conclude that Dr. Langmuir's concentration on the problems of physics has prevented him acquiring any knowledge, even intuitive, of unconscious cerebration ?

Dr. Langmuir's conceptions of the psychology of reasoning will prepare biologists for his confession that he finds the idea of fitness to survive "inherently rather fuzzy".

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SOME of Dr. I. Langmuir's ideas on modern trends in scientific thought[1] require comment.

It is significant, I think, that the resurgence of metaphysics, spiritualism, etc., among scientific men has been mostly confined to physicists. Their entities —atoms, electrons, quanta—are all things which cannot be observed directly by the senses, so perhaps we can understand their doubt as to the relation of their concepts to reality. On the other hand, their knowledge of the biological sciences is not usually such as to give them that confidence in the power of scientific method which is pronounced in modern biologists.

It is important to distinguish clearly between concept and reality. The chemist's 'atom' may differ from the physicist's 'atom', but both are only aspects, imperfectly understood, of a real material atom. As science progresses the gap between concept and reality decreases, but only ideally can they coincide. The uncertainty principle, for example, is a concept which has no bearing, as Dr. Langmuir would suggest, on the *reality*, which is that at any moment a particle has both a definite position and a definite velocity, and that both are determined by its external and internal conditions.

That physicists have been unable to find immediate causes for the emission of an alpha particle from a certain radium atom is no reason for asserting that such emission is without cause. It is at present impossible to predict which side up a penny will fall, but it is actually determined by which is the original side up and the number of somersaults the penny makes before coming to rest. Owing to man's common sense, he has searched for a cause for everything; where his knowledge has failed him he has substituted the supernatural. Dr. Langmuir would have us substitute nothing, and declares such phenomena to be beyond the bounds of science. This is not a very happy philosophy for the dawn of the scientific era.

Divergent phenomena are, by Dr. Langmuir's definition, large effects produced from small beginnings. We are told these phenomena do not obey the laws of cause and effect. The very use of the word 'produced' implies causation. The establishment of a mutation in a population through natural selection is an example of such a phenomenon. It can be seen that 'divergent' phenomena are merely the expression of improbable events due to their coincidence with the correct environment for that expression.

Classical and quantum physics are two aspects of the same reality studied on different scales. Mass effects are the statistical integration of an internal conflict between probabilities. This internal conflict is universal in all phenomena from the physical to the sociological. Just as the unit which shows heterogeneous behaviour is in physics the atom or energy quantum, so in sociology it is the individual, and one can induce laws of society, ignoring individual idiosyncrasies.

A. J. BATEMAN.

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[1] NATURE, 151, 266 (1943).

Czechoslovak Medical Students at Oxford

IN connexion with the historic ceremony at Oxford on February 27 when Czechoslovak medical degrees were conferred on twenty-three Czechoslovak medical students, it is of interest to recall that on February 25, 1586/7, Wencelaus (Václav) Lavinius (that is Lavický), a Moravian who had studied medicine for twenty years in France, Germany and Italy, and had been licensed to "incept in medicine" at Wittenberg "sub Pensero", was admitted as M.D. of Oxford on condition that he gave three "solennes lectiones" before his departure[1]. He had presented letters o introduction from Sir Francis Walsingham, and from Massionius Fontanus and J. Castolus, "pasteurs" o the French church in London. Castolus's lette stated that Lavinius had spent a year in London, had brought a letter of introduction from Beza of Geneva, and that he was "rector peregrinationum et famili præfectus" of Baron di Zerotini (that is, z Žerotin) a Moravian.

R. FITZGIBBON YOUNG.

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[1] For references see R. Fitzgibbon Young, *English Hist. Rev.*, Ja 1923.

THE BRITISH EMPIRE CANCER CAMPAIGN

ANNUAL REPORT

THE nineteenth annual report of the British Empire Cancer Campaign, which was recently issued, is much thinner than reports of previous years. It is, however, much condensed, and the usual index and many lists of names have been omitted. All the cancer research centres in Great Britain appear to be still carrying on, so that in the future it should be possible for the work to expand and to make rapid progress.

Virus Research

Pure lines of fowls have been used to advantage in the study of avian tumours at the Middlesex Hospital, London. A strain of Plymouth Rock fowls is very susceptible to the action of carcinogenic agents, while a strain of Brown Leghorn fowls is resistant to such agents and also readily forms antibodies to the Rous sarcoma virus. The variability in susceptibility of Brown Leghorn fowls to the virus is reflected in their ability to produce neutralizing antibodies and agglutinins. The antibodies present, however, may be ineffective in preventing the subsequent growth of tumours. This is probably due to the growth of the tumour cells coupled with increase of virus within the growing cells, in such a way that the virus does not come in contact with the circulating antibodies. Immunity to filterable tumours therefore is less certain than immunity to other virus diseases.

Dr. M. H. Salaman, of St. Bartholomew's Hospital Cancer Research Department, working with Dr. D. E. Lea, has studied the action of X-rays on vaccinia virus elementary bodies. The particles contain only a small amount of radio-sensitive material, but this is dispersed throughout the volume of the elementary bodies. In contrast to this animal virus, the radio-sensitive part of a crystallizable plant virus occupies almost the whole of the volume of the particles. Photomicrographs of vaccinia elementary bodies taken by means of an electron microscope show that they are oval in shape.

Carcinogenic Action

The possible carcinogenic effect of heated fats has been further investigated at the Glasgow Royal Cancer Hospital. When rats were fed on a diet of bread, milk, water and heated fats, non-malignant ulcerated papillomata developed in the stomachs of some animals. Since white bread ceased to be available, the rats have been given National bread and no papillomata have been seen.

Workers at the Royal Cancer Hospital are preparing and testing compounds for carcinogenic action and growth-inhibitory power with the object of finding new substances worthy of therapeutic trial.

Dr. I. Berenblum suggests that injected benzpyrene must remain unchanged in the tissues for some time if it is to produce tumours. If benzpyrene is injected subcutaneously, it remains at the site of injection for some time and tumours are formed. If it is injected into the peritoneum, it disappears rapidly and no tumours result. Less than one per cent of injected benzpyrene is excreted as unchanged material, but a considerable amount is excreted as a monohydroxy derivative. Dr. I. Berenblum and Dr. R. Schoental have now isolated benzpyrenequinone from the fæces of rats which had been injected previously with benzpyrene. This quinone is possibly derived from a dihydroxy compound.

Benzpyrene in true solution has a violet fluorescence, but in the animal body it is converted into *BPX*, which has a blue fluorescence; *BPX*, in the presence of intestinal contents, is changed into a substance with a green fluorescence. Prof. F. Weigert and Dr. I. Doniach at the Mount Vernon Hospital have observed a violet fluorescing wave passing down the alimentary tract of mice which had been given benzpyrene by mouth. The benzpyrene was absorbed so that the violet fluorescence spread to the fatty tissues, and afterwards a blue fluorescence was seen in the kidney and *BPX* appeared in the bile. When the common bile duct was ligated, the blue fluorescing *BPX* was unable to pass into the intestine but accumulated in the plasma and was deposited in the lung, liver and intestinal wall. *BPX* was not absorbed from the gut. These observations amplify results obtained in this field both in Glasgow and Oxford.

Dr. J. C. Mottram reports that carcinogenic hydrocarbons caused some hæmolysis of erythrocytes in isotonic saline, but the same hydrocarbons increased the resistance of the cells to hæmolysis in hypotonic solutions. These effects were much reduced if proteins were present, and it is suggested that the protective action of proteins may account for the failure of carcinogens to induce cancer cells in tissue culture.

Heredity

The experiments of Andervont and of Bittner in America have shown that a factor influencing the incidence of breast cancer in mice is transmitted from mother to offspring through the milk. This factor is present in the milk of mice from strains with a high incidence of breast cancer. Dr. G. M. Bonser has been able to demonstrate the effect of the factor in male mice. Male mice of the *CBA* strain, in which the incidence of breast cancer even in females is low, have developed tumours of the breast following injection of triphenylethylene only when they have been suckled by mice of the *R* III strain. On the other hand, the incidence of breast tumours in mice of the *R* III strain, which is usually high, was reduced if they had been suckled by *CBA* mice.

Successful experiments on cross-fostering have also been carried out at Newcastle-on-Tyne, where Dr. F. C. Pybus and Dr. E. W. Miller increased the incidence of breast tumours in *CBA* female mice from 5 per cent to 60 per cent by allowing them to be suckled by mice of the Simpson strain. Further confirmatory evidence of the existence of this extra-chromosomal factor has also been obtained at the Marie Curie Hospital.

An examination of the incidence of cancer in the mothers and sisters of patients suffering from breast cancer, made by Miss L. M. Wainman in Leeds, shows the incidence to be no higher among the relatives of the patients than in the general population. This result is of interest, particularly as it is different from the findings of Wassink in Holland. As most infants are suckled, the present observations indicate that, in the section of the population examined, there is not likely to be a factor influencing the incidence of breast cancer transmitted through human milk.

Radiations

Mouse tumours have been irradiated with neutrons in order to determine the amount of radiation which is necessary to produce tumour regression. This work, carried out at the Mount Vernon Hospital, shows that the neutron dose is only one-twentieth to one-thirtieth of the X-ray dose which would be required to produce the same response.

Dr. J. S. Mitchell has photographed tissues, before and after irradiation with X-rays, using ultra-violet light of wave-length 2537 A. The absorption of light of this wave-length by the cytoplasm increases on irradiation, and this has been shown to be due to accumulation of nucleotides. There is no comparable increase in nucleic acid content of the nuclei, and it is suggested that X-rays inhibit the reduction of nucleotides to desoxynucleotides and so prevent the formation of nucleic acid.

Growth Factors

Extracts of bacteria and of some fowl tumours contain a growth-stimulating factor which reduces the delay in the growth of *Staphylococcus aureus*. Prof. H. N. Green and Dr. F. Bielschowski have been able to concentrate the factor and show that it has the properties of a weak acid. The same workers have examined some derivatives of the carcinogenic insecticide, 2-acetylaminofluorene. The growth of rats and of bacteria was inhibited by 2-aminofluorene. These results indicate that the factors which govern the growth of bacteria and of tumours may be similar.

Clinical Research

An analysis has been made of the histological findings from specimens obtained from mastectomies carried out at the Middlesex Hospital over a sixteen-year period. Nineteen cases of malignant disease in the male breast were found. Only three cases of extensive non-malignant epithelial overgrowth in males were seen, and of these two were from men who had worked with stilbœstrol.

The Clinical Cancer Research Committee has now analysed the data from four hundred and seventy-three cases of carcinoma of the œsophagus. The prognosis for this form of cancer is bad; only thirty-four of the patients were known to have survived for more than a year after the original diagnosis had been made.

The British Empire Cancer Campaign would be doing useful work if it were merely able to keep the various cancer research institutions just 'ticking over'. It is, however, doing much more than this, as the present report amply shows. E. Boyland.

CONTROL OF RAW MATERIALS

The report on the work of the Combined Raw Materials Board to January 26, 1943, which has recently been issued over the signatures of the two members of the Board, Mr. W. L. Batt, vice-chairman of the War Production Board, United States, and Sir Clive Baillieu, head of the British Raw Materials Mission in the United States, outlines the measures taken since the Board was set up on January 26, 1942. The report demonstrates that international co-operation on a large scale and on a day-to-day level can be markedly successful in getting the resources of each country used to the best common advantage. Without combined machinery, the settlement of each joint problem as it arose through contacts which would not continue after their purpose had been achieved, and which would not provide experience and knowledge to be applied to other problems, would inevitably have been surrounded with difficulties and obstacles involving delay, uncertainty and dissatisfaction. As it is, very real progress has been possible towards a planned and expeditious utilization of the combined raw material resources in the prosecution of the War.

The Board's primary duty was to bring under authoritative review the combined supply and requirements position for those materials which are in such limited or precarious supply as to endanger any part of the total war effort. The materials selected for review were those for which there was *prima facie* evidence for concern. Initially, they were materials of which the supply had been affected or threatened by enemy action in the Far East, such as rubber, silk, tungsten, tin and manila hemp and sisal. In other cases, for example, the principal non-ferrous metals, it was important to take all necessary precautions in view of the unprecedented demands which the combined military programmes were imposing upon normal sources of supply. In a third class were materials which gave rise to operating or purchasing problems where both the United States and Great Britain, together with others of the United Nations, might be in active competition in the various markets for limited supplies.

The common factor in all the Board's materials reports is that it has provided for the first time, through combined machinery not previously in existence, an official assessment of the total position. The reports draw together in one document a combined statistical survey of requirements and supply for one or two years ahead; a review of possible interruptions to future supply, and of measures in progress or desirable to increase output; and a consideration of the problems of conservation and substitution. The Board exercises its authority through recommendations to the departments and agencies of the American and the British Governments already responsible for the supply and distribution of raw materials within their fields, and based on its reports these recommendations have been directed towards balancing supply and demand through allocations, maintenance or increase of supply, conservation and economy in use, co-ordination of the purchasing and development activities of the two countries in the various markets and shipping adjustments.

For most materials the maintenance and stimulation of output is a matter of fundamental concern, and for such materials as rubber, copper, tin, nickel, cobalt, tungsten, mica, zinc, balsa and sisal, the Board has gone considerably beyond general indications and has made specific recommendations as to the places at which development should be undertaken and the methods or organization which should be used. In regard to conservation, the principal direct contribution of the Board has been to secure and co-ordinate exchanges of technical information and experience. This action has brought in so far as possible the other United Nations, and such exchanges ave been of particular importance where the more beral use of a scarce material in one country than in nother is due, at least in part, to undeveloped technical rocesses and equipment. Recommendations made n this point in connexion with tungsten, tin, cobalt, ica, copper, zinc, graphite and asbestos have in ome instances been reinforced by an advisory interhange of technicians. A special liaison has been set p to centralize the activities of the Board in a field overing a wide variety of commodities, and parcularly to provide a defined channel for the exchange f information on matters of conservation.

Liaison has throughout been maintained with the arallel Combined Boards, and a Joint Advisory ommittee has been set up with the Combined Food oard for questions relating to fertilizers. The Comined Production and Resources Board has been rovided with a statement of the estimated supply the end of 1943 for steel ingots and the key aterials aluminium, rubber and copper, as well with combined supply requirements summaries for me twenty-four materials actually or potentially in ch short supply as to endanger any part of the oduction programme.

In regard to collaboration with others of the nited Nations, through machinery already developed y the State Department and the Board of Economic arfare in Washington and by the British Commonealth Supply Council in London, as well as by rect discussions and negotiations, the resources of entral and South America, the Belgian and French erseas territories, the British Commonwealth and iendly neutrals have been and are being mobilized. or the U.S.S.R. requirements are covered in the otocol Agreements in amounts which are adopted the Board in any general allocations. Discussions ve taken place between representatives of the S.S.R. and Britain and the United States with gard to the supply of certain materials from ussia.

With the passing of a greater range of materials to the category of "short or critical supply", it came necessary for the two countries closely to -ordinate the planning of their export programmes volving such materials. A Combined Export arkets Committee was therefore set up under the spices of the Board to watch over the export ogrammes of both countries for certain scarce terials, to ensure that the requirements of the porting countries are, so far as possible, met, but a carefully controlled assessment of essential eds comparable to that obtaining in the United ates and Great Britain. On this basis the Comttee agrees upon joint export programmes in the ht of the other factors involved—shipping, labour, litical and financial considerations, maintenance of rmal channels of trade, etc.

The report thus shows that the Board has been e to exercise its function of planning the raw terials side of the combined war effort in three ncipal ways. First, agreement has been secured, ough the Board, between the two Governments cerned, to common action in regulating supply, tribution and use of the major strategical materials, h the object of ensuring that each country is put a position to make its maximum contribution to war effort on the production side. Secondly, by nging the authorities of the two countries together co-operative arrangements for purchasing and ply, a scramble has been prevented for those ondary' materials which are, in their place, essential to the production programmes. Thirdly, the Board and its machinery have formed a centre for the discussion of day-to-day problems affecting either country, and for the compilation of information and evidence on which alone an effective solution for those problems can be based. The extent to which those facilities have been freely and fully used by the Governments concerned, and the fact that although the Board has no executive authority its recommendations have never been disregarded, offer the strongest justification for the hope that this machinery of joint control over world-wide resources will be continued and given wider scope to prevent a wild scramble for the diminished supplies after the War, frustrating our hopes for the most fruitful use of the world's resources in recovery.

AIR-BLAST CIRCUIT-BREAKERS

A PAPER read in London on March 4 before the Institution of Electrical Engineers by A. R. Blandford discusses notable improvements in circuit-breaker design with reference to the reduction in oil quantities and to its elimination.

The trend in the design of modern high-power circuit-breakers has always been in the direction of reducing the quantity of oil necessary for arc interruption. A decided step in this direction was the introduction of the arc-control device which confined the arc within an arcing chamber surrounding the contacts during arc interruption. The application of such devices, which usually take the form of a small container of liquid with restricted venting enclosed in the main containers of liquid, made possible a considerable reduction in oil quantity, particularly at the higher voltages. More recently, there has developed a strong demand for oil-less circuit-breakers.

Other forms of circuit-breakers using various extinguishing media have been developed, but only the two forms, oil and air-blast, have found general favour, and of these the growing popularity of the latter is accounted for by a proper appreciation of its superiority in principle of operation and behaviour. The inherent advantages in their order of merit are freedom from explosion, elimination of oil-fire hazard, mechanical simplicity, suitability for duties requiring frequent operation, cleanliness of maintenance and operation, reduced maintenance, and facility for power closing.

The principle of the axial blast can be applied readily to voltages from 6·6 kV. upwards at standard ratings. The question of susceptibility to rates of rise of recovery voltage can be overcome with ease by the incorporation of parallel resistors, which also limit harmful over-voltages. Air-blast breakers provide freedom from the dangers of explosion and they eliminate fire hazard completely. They are positive in operation and result in minimum arcing times at all values of current. They sustain a minimum deterioration of contacts, resulting in long life for repetitive operation. 'Making' contacts are exposed for ease of inspection. Clean and speedy inspection of arcing contacts is possible, only about three minutes being required to dismantle and inspect one interrupting chamber. Large-capacity batteries with their problems of regulation for closing purposes are eliminated.

FORTHCOMING EVENTS

Saturday, April 17

British Rheologists' Club (*joint meeting with the Manchester and District Section of the Institute of the Rubber Industry*) (at the Engineers' Club, Albert Square, Manchester), at 10 a.m.—Discussion on "The Rheology of Rubber and Rubber-like Materials" (Chairman: Mr. W. N. Lister).

Monday, April 19

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Infra-red Lamp Heating and its Application to Industrial Purposes".

Tuesday, April 20

Royal Statistical Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. J. Thompson: "The Future of Agriculture".

Institution of Electrical Engineers (Wireless Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Metal Rectifiers and their Applications to Radio and to Measurements" (to be opened by Mr. S. A. Stevens).

Wednesday, April 21

Royal Society of Medicine (at 1 Wimpole Street, London, W.1), at 2.15 p.m.—Annual General Meeting. Discussion on "Immunity", 5, "Immunity to Viruses" (to be opened by Sir John Ledingham, C.M.G., F.R.S., Mr. T. M. Doyle, Mr. J. T. Edwards and Mr. N. Dobson).

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.30 p.m.—Meteorological Sound Films: (1) "Ice Formation"; (2) "Temperature and Pressure"; (3) "Synoptic Meteorology": (4) "Tactical Use of Clouds": (5) "Fog". (By courtesy of the Air Ministry.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Speech Therapist—The Director of Education, Education Offices, Peel Street, Huddersfield (April 24).

Assistant Teacher of Mathematics and Science in the Oldbury Technical School—The Director of Education, County Buildings, Worcester (April 24).

Assistant Master to take Science and Mathematics in the Junior Technical School—The Director of Education, Education Offices, Union Street West, Oldham (April 24).

Teacher of Mining Subjects in the Doncaster Technical School—The Chief Education Officer, Education Offices, Wood Street, Doncaster (April 26).

Research Assistant—The Secretary, Animal Diseases Research Association, Moredun Institute, Gilmerton, Midlothian (April 26).

Assistant Lecturer in Agricultural Chemistry—The Registrar, The University, Leeds 2 (April 28).

Teacher of Science Subjects (Physics and Chemistry) in the Batley Technical College and School of Art—The Director of Education, Education Offices, Batley, Yorks. (April 28).

Physicist (male) to the Radiotherapy Department—The Secretary, London Hospital, London, E.1 (April 30).

Borough Electrical Engineer—The Town Clerk, Town Hall, Luton (May 1).

Teacher of Building Construction, Science and Mathematics in the Building Trades and Junior Day Department of the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Offices, 77 George Street, Oxford (May 1).

Lecturer in Mining and Fuels—The Principal, Huddersfield Technical College, Huddersfield (May 7).

Lecturer (woman) in Geography in the Brighton Municipal Training College—The Education Officer, 54 Old Steine, Brighton (May 8).

Graduate Lecturer in Mathematics and Science—The Clerk to the Governors, Technical College, Chesterfield.

Speech Therapist—The Education Officer, County Hall, Wakefield.

Second Assistant Port Engineer for the Basrah Port Directorate, Iraq Government—The Secretary, Overseas Manpower Committee (Ref. 541), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

Mechanical and Electrical Engineer for the Gold Coast Government Public Works Department—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Section D.588, Alexandra House, Kingsway, London, W.C.2.

Assistant Mechanical Engineer for the Tanganyika Government Railway—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Ref. C.1334, Alexandra House, Kingsway, London, W.C.2.

Lecturers in Mechanical and Electrical Engineering Subjects—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Section D.565, Alexandra House, Kingsway, London, W.C.2.

Assistant Master, with good qualifications in Electrical Engineering, at the Maidstone Technical Institute—Mr. A. W. Peacock, 13 Tonbridge Road, Maidstone, Kent.

REPORTS and other PUBLICATIO

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Tin Research Institute. Publication 115: Determinatio the Thickness of Tin Coatings. Pp. 6. (Greenford: Tin Res Institute.)

British Rubber Producers' Research Association. Publicatior 30: The Elasticity of a Network of Long-chain Molecules, 1. L. R. G. Treloar. Pp. 8. (London: British Rubber Producers search Association.)

National Institute of Economic and Social Research. Occas Papers, 2: *The Population of Bristol*. By H. A. Shannon ar Grebenik. Pp. v+93. (Cambridge: At the University Press.) 7 net.

Proceedings of the Royal Irish Academy. Vol. 48, Sectio No. 4: Dynamics and Scattering Power of Born's Electron. Erwin Schrödinger. Pp. 91–122. 1*s*. 6*d*. Vol. 48, Section A, N On Ideals in the Cayley-Dickson Algebra. By K. Mahler. Pp. 134. 1*s*. Vol. 48, Section A, No. 6: Pentads, Tetrads and Tria Meson-Matrices. By Erwin Schrödinger. Pp. 135–146. 1*s*. Vo Section B, No. 8: Mean Geochemical Data in relation to Oc Evolution. By E. J. Conway. Pp. 119–160. 2*s*. Vol. 48, Sectic No. 9: The Chemical Evolution of the Ocean. By E. J. Conway. 161–212. 2*s*. 6*d*. Vol. 48, Section B, No. 10: The Mobile Coll Humus of Podsolic Soils and its relationship to the Process of solisation. By Patrick H. Gallagher. Pp. 213–230. 1*s*. Vol. 48, Se B, No. 11: Granitisation of Hornfelsed Sediments in the N Granodiorite of Goraghwood Quarry, Co. Armagh. By Dori Reynolds. Pp. 231–268. 3*s*. (Dublin: Hodges, Figgis and Co., I London: Williams and Norgate, Ltd.)

Ministry of Fuel and Power: Committee on the Efficient U Fuel. Fuel Efficiency Bulletin No. 9: Combustible Material in A Pp. ii+10. Fuel Efficiency Bulletin No. 10: Control of Exces *on Steam Raising and Central Heating Plants*. Pp. 12. (Lon Ministry of Fuel and Power.)

The Super Church: a New Church, a New Bible and a New formation for a New World; a Challenge to Religious and Religious Diehards. By W. Margrie. Pp. 32. (London: The Au 65 Trafalgar Avenue, S.E.15.) 6*d*.

A Post-War Agricultural Policy for Great Britain. A Memorar prepared by a Group of Peers holding varied Political Creeds. P (London: Vacher and Sons, Ltd.)

Other Countries

Proceedings of the United States National Museum. Vol. 92, 3152: The Fresh-water Fishes of Liberia. By Leonard P. Sch Pp. 301–348+plates 35–36. (Washington, D.C.: Government P ing Office.)

Smithsonian Institution: Bureau of American Ethnology. Bul 134: *The Native Tribes of Eastern Bolivia and Western M* Grosso. By Alfred Métraux. Pp. ix+182+5 plates. 35 cents. Bul 135: Origin Myth of Acoma and other Records. By Matthew Stirling. Pp. viii+123+17 plates. 35 cents. (Washington, I Government Printing Office.)

Anuario del Observatorio Astronómico de Madrid para 1943. 236. (Madrid: Instituto Geográfico.)

Events in African History. A Supplement to 'The Atlantic Ch and Africa from an American Standpoint'. Compiled by Edwi Smith. Pp. iv+67. (New York: Committee on Africa, the War Peace Aims; London: Edinburgh House Press.) 1*s*.

Records of the Geological Survey of India. Vol. 77, Professi Paper No. 4: *The Structure of the Tertiaries near Gogha, Kathia* By J. A. Dunn. Pp. ii+10+4 plates. 1 rupee; 1*s*. 6*d*. Vol Professional Paper No. 5: Coal in Kathiawar. By J. A. Dunn. ii+12. 4 annas; 5*d*. (Calcutta: Geological Survey of India.)

Imperial Council of Agricultural Research. Miscellaneous Bul No. 48: Methods of Production and Marketing of Cigarette Cigar Tobacco in the United States of America, Canada, Java Sumatra. By C. V. S. Chatty. Pp. v+91+12 plates. (Delhi: Mar of Publications.) 4.4 rupees; 6*s*. 9*d*.

Indian Forest Leaflet No. 29: Selection and Field Testin Aircraft Quality Spruce and Fir. By V. D. Limaye. Pp. ii+ plate. 4 annas; 6*d*. Indian Forest Leaflet No. 30: Formatic *Clinker in Producer-Gas Plant*. By S. Ramaswami and A. C. Pp. ii+4+1 plate. 6 annas; 9*d*. Indian Forest Leaflet No. Wood Disc Dowel Joints in Timber Framed Structures. By V Limaye. Pp. ii+6+2 plates. 4 annas; 6*d*. (Dehra Dun: F Research Institute.)

Annals of the Carnegie Museum. Vol. 29, Art. 12: List of Hummingbirds in the Collection of the Carnegie Museum. By W Clyde Todd. Pp. 271–370. (Pittsburgh, Pa.: Carnegie Museum.)

City of Durban: Durban Museum and Art Gallery. Annual Re for the Year ended 31st July 1942. Pp. 8+4 plates. (Durban: ban Museum and Art Gallery.)

Union of South Africa: Department of Agriculture and Fore *Science Bulletin No. 20 (Chemistry Series No. 171)*: The Cher Composition of some South African Cereals and their Milling Prod By D. C. Crawford, Dr. P. J. Hamersma and Dr. B. W. Marloth. 100. (Pretoria: Government Printer.)

U.S. Office of Education: Federal Security Agency. Bulletin No. 6: Industries, Products and Transportation in our Neig Republics; an Index and Bibliography. Pp. iv+39. (Washing D.C.: Government Printing Office.) 10 cents.

Australasian Antarctic Expedition, 1911–14. Scientific Rep Series A, Vol. 1: Part 1, Narrative; Part 2, Cartography. By Do Mawson. Pp. 364+124 plates. (Sydney: Government Prin £3 17*s*. 6*d*.

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CONTROL OF CHEMICAL AND MINERAL PRODUCTS

It is generally agreed that the restraint of potential aggressors must be a prolegomenon to any planned reconstruction of the post-war world. History does not provide us with any comforting hopes in this connexion, but during this last German war the tempo of destruction, cruelty and misery (and also that of lying and slandering) has risen so greatly, and physical means of communication and control have developed so rapidly, that the prospect of curbing Mars, if not of slaying him, may no longer be regarded as chimerical. It is also generally agreed that the measures prescribed to this end at Versailles in 1919, and in subsequent treaties and pacts, have failed dismally. In what directions, then, shall we now look ? Having experienced the futility of pious pacts and the boomerang effects of vindictiveness, shall we now pin our faith to an effective international police force ? Shall we make ourselves overwhelmingly strong, and keep our potential enemies so abjectly weak that they cannot have recourse to war ? Or could we by some political *tour de force* succeed in segregating or dispersing dangerously hostile populations with the view of incorporating them in some stable, peace-abiding confederation ?

In the long run, the will to war might be eradicated by what is called a 'change of heart' ; in the shorter run, much progress in the desired direction could probably be achieved by a drastic reform of current educational methods, and by implementing an all-round policy of social security. But long before such changes could be effective, some means—political, economic, technological—must be taken to cut the claws of any lurking beast of prey, if only to give the world breathing-time to recover from its present plight. If the beaten enemy is again allowed to attain a 'giant's strength', he will again not hesitate to 'use it like a giant'. At the same time, it is well to remember that "Who overcomes by force, hath overcome but half his foe".

Any one nation that undertook to make and keep itself overwhelmingly strong in the military sense would incur a crippling economic burden, a grave deflexion of man-power from truly constructive to purely destructive ends, and an unhealthy maintenance of the martial spirit. To keep potential enemies in a permanently weak state, physically, economically and politically, would foster among them a sense of frustration, bondage and injustice, and thus sow the seeds of a future war. In any event, for many years to come we must learn from our fateful experience of the past one hundred and fifty years, and be prepared militarily for a sudden emergency ; and any long-term policy we adopt must be so conceived that, while restraining the martial powers of potential aggressors, it does not jeopardize the success of any future eirenicon.

The profound horror evoked by the mass murder of non-combatants, by the brutalities committed in concentration camps, and by the persecution of Jews and other subjugated peoples might readily lead to ruthless repression and even to biological reprisals. Such policies would, however, be virtually sentence of extermination ; they would do nothing for the betterment of human relations. Like greed, vindictiveness can easily overreach itself.

A less drastic, and probably a thoroughly practical proposal, would be to place an embargo on the importation of certain raw materials that are essential to war-time use. This was the policy put forward, in respect of 'key' minerals and metals, by Sir Thomas Holland before the South African meeting of the British Association in 1929, and again under the same auspices at the Conference on Mineral Resources and the Atlantic Charter, in July 1942 (see NATURE, Sept. 26, 1942, p. 364). No nation possesses within its own territory all the resources that would be adequate to conduct a long war, or for that matter to thrive economically in time of peace. For example, Germany and other parts of central Europe lack nickel, manganese, chromium, tungsten, cobalt, molybdenum and vanadium, and such substances cannot be produced synthetically, like petroleum, rubber, fibres and camphor. In view of the development of carrier-aircraft, there might well be difficulty in preventing the importation of 'key' materials required only in relatively small amount, for example, platinum and the rarer metals and minerals, but in general such a ban on exotic 'key' materials would do much to deprive an aggressive Power of the means of continuing a protracted war, provided always that there was an international authority adequate to control the ingress of supplies.

Another method of disarmament was suggested by Sir Robert Robinson at the annual luncheon of the Parliamentary and Scientific Committee, namely, to prevent the manufacture of war-time explosives by abolishing all large-scale plants making synthetic ammonia, and plants making methanol, as these can be used for making ammonia. In this way, the large-scale production of nitric acid, which is the basis of practically all explosives used in war, could be effectually stopped. No explosives—no war, was his thesis.

It may be recalled that before the War of 1914–18, nitric acid, for all purposes, was made almost exclusively from Chile saltpetre by interaction with sulphuric acid, but that shortly before its outbreak, Germany had elaborated and established the Haber-Bosch process of making ammonia by fixation of atmospheric nitrogen, the ammonia being oxidized to nitric acid by the Ostwald process. By this means Germany made herself entirely independent of imported nitrate for the manufacture of explosives and for use as fertilizer. After that War, many countries, including Great Britain, adopted the Haber-Bosch process, a modification of it, or some other process of fixing atmospheric nitrogen. To-day there are many such plants dotted over the civilized world ; and of recent years their combined productive capacity has been well in excess of peace-time demands. The result is that none of these countries need, in case of emergency, import a single ounce of Chilean nitrate (though there is plenty of it still available). The synthetic ammonia works in Germany (but not the ammonia-oxidation plants) are concentrated in a few centres, and Sir Robert Robinson believes that an International Nitrogen Commission would have little difficulty in maintaining the 'sanction', though he would allow the manufacture of sulphate of ammonia after a term of years. No mention was made, however, of the fact that a very large amount of ammonia is obtained as a by-product in the manufacture of metallurgical coke and of town's gas. There is little doubt that the works producing these products could be considerably enlarged or the number of them be increased ; the gas-works are widely dispersed, and supervision of them would entail a vast amount of police work.

The elimination of the huge synthetic ammonia works, and the ensuing drastic reduction in output of nitric acid, would put a temporary check on the production of explosives, but it would also have other consequences. It would deal a very serious blow to various peace-time chemical industries in the controlled countries, and so react adversely on their economic status. Ammonia, besides being used for the manufacture of nitric acid and such important fertilizers as sulphate of ammonia and ammonium phosphate, is also used in the manufacture of alkali by the Solvay process, and as a refrigerant, etc. Nitric acid has also a multiplicity of applications. It is of paramount importance in the manufacture of dyes and intermediates ; in fact, it is difficult to imagine a dyestuffs industry without it. There is also to be considered the possibility, if its large-scale manufacture from synthetic ammonia were banned, that another technical process of manufacture might arise in its place, such as one based on the use of ammonifying and nitrifying bacteria, which play so important a part in agriculture.

Among other 'key' chemicals of which the production might come under the ban, sulphuric acid is of first importance, being used not only in the manufacture of explosives, like nitroglycerine, gun-cotton and T.N.T., but also in a host of other industries, either as a starting material or for purifying and refining purposes. Although a process for making sulphuric acid from calcium sulphate (as gypsum or anhydrite) was worked out in Germany about the time of the War of 1914–18, practically all of it is still made from sulphur, obtained mainly from the United States, or from pyrites, derived chiefly from Spain or Norway. It would probably be much easier to prohibit the importation of these raw materials than to police a whole country with the object of preventing their use in sulphuric acid plants. Of other chemicals, apart from metals and metallic compounds, that are needed for war-like purposes, it may be said that the majority can now be produced from indigenous raw materials. Thus phosphorus, for use in incendiary bombs, etc., can be extracted from bones and low-grade phosphatic minerals ; glycerin, which is normally derived from natural fats and fatty oils, can now be made synthetically ; calcium carbide, ethyl and methyl alcohols, ether, acetic acid, acetone and formaldehyde, phenols and urea needed for plastics manufacture—all these can be produced from raw materials that are close at hand.

It appears doubtful, therefore, whether the suppression of the large-scale manufacture of 'key' chemicals, or, in fact, of any vital manufactured product, would be so promising as a measure of restraint as the control of the importation of 'key' minerals and metals. Both suggestions will have to be given careful consideration. But for any such measure to be really effective, there must be a much greater degree of co-operation among the peace-loving Powers than any we have seen in the past. Disarmament in the literal sense will no doubt be the first step, the *terminus a quo* for the long, long journey to the *terminus ad quem*, international pacification, the speed of which would be accelerated by some far-sighted political action, such as the dispersal of potentially hostile or recalcitrant minorities into regions where they would be harmless, and the incorporation of them into larger peace-abiding confederations possessing the maximum amount of freedom consonant with international security.

JOHN RAY

John Ray, Naturalist
His Life and Works. By the Rev. Dr. Charles E. Raven. Pp. xix+502. (Cambridge: At the University Press, 1942.) 30*s.* net.

No one who studies with attention the historical development of biology can be long in doubt as to the place to be assigned to John Ray. It may be, as Dr. Raven suggests, that his name is not so well known to present-day biologists as it was to those who founded the Ray Society a hundred years ago; but, if so, it must be because the present-day biologist tends regrettably to be uninterested in the history of his science and, no less regrettably, to regard classification as no concern of his. Not that Ray imagined, as Linnæus did, that systematics was the end and aim of natural history; but to the botanists and zoologists of the seventeenth century, faced by the bewildering variety of living things, classification was the primary and most pressing need. Ray approached the problem in a spirit in many ways surprisingly modern. Others had arranged animals and plants as fitted the subject under discussion, geographically, ecologically, or on the basis of their utility to man. It was Ray who first clearly expressed the conception of a 'natural' classification based solely on structural resemblances and differences; it was he who first discussed the still unanswered question: 'What is a species?' It is true that he had no inkling of a genealogical basis for classification, but no one had in the seventeenth century.

Ray's fame has been to some extent overshadowed by that of his great successor Linnæus, but, as Dr. Raven says, "there can be no sort of doubt that Ray had the truer appreciation of the real task of a scientist". Linnæus had, in a superlative degree, the pigeon-hole type of mind. Had he lived in our times he would have been a great deviser of card-indexes and filing systems. He invented a method of 'running down' the species of plants which made botany a popular pastime with the dilettanti of the eighteenth century. His system of binomial nomenclature is still used, for labelling our museums and herbaria, and no one has yet suggested a workable substitute; but in all that concerns the structure and life-processes of organisms he was far from showing Ray's knowledge or insight. Sachs' judgment that Linnæus "never made a single important discovery throwing light on the nature of the vegetable or animal world" will scarcely be disputed nowadays.

Hitherto it has been difficult to form any clear idea as to what manner of man this was whom Gilbert White called "Our countryman, the excellent Mr. Ray". He has been singularly unlucky in his biographers. His friend Dr. Derham, who wrote a sketch of his life and published his "Philosophical Letters" (selected from a much larger number now lost), intentionally omitted most personal details and concentrated on what he supposed to be of scientific importance; "of this", Dr. Raven drily remarks, "he was not always a good judge". Edwin Lankester, who edited Derham's "Life" and a further selection of letters for publication by the newly founded Ray Society, was ill-equipped for the task. The late Dr. R. W. T. Gunther, in the "Further Correspondence" published by the Society in 1928, brought to light a considerable number of unpublished letters and reduced to order much of the chaos created by previous editors, but did not try to tell a connected story.

Now at length we have a worthy biography, scholarly and sympathetic, which is not likely to be soon superseded as the standard authority on Ray's life. Dr. Raven, indeed, deplores that his lack of systematic training in biology disqualifies him from pronouncing judgment on Ray's position in the history of science, but it is not quite certain that this lack is matter for regret. He has escaped, at any rate, the myopia of the specialist and, on the other hand, he is, like Ray, an experienced and enthusiastic field-naturalist. "I have collected nearly all the plants, birds and insects that he records, and often in the same localities." Like Ray he can say "Divinity is my profession", and as a humanist he can appreciate Ray's "masterly" Latin, his interest in philology, and his pioneer work in the study of English dialects.

In all the mass of Ray's correspondence that has survived there are remarkably few references to his personal affairs. The letters are concerned almost exclusively with scientific matters and seldom reveal, even by accident, anything of the man himself. He had been corresponding with Edward Lhwyd for some ten years when the death of his little daughter Mary breaks down his habitual reserve. "You may possibly have heard, though I do not remember I ever told you, that I had four daughters." Dr. Raven points out that letter-writing of this impersonal kind was the means by which men of learning kept in touch with each other until "periodicals and meetings of learned societies superseded it and . . . means of communication made travel and talk easy".

Dr. Raven alludes to the "unpleasant controversy" that arose about a century ago as to Ray's share in the "Ornithology" of Francis Willughby which Ray edited and published after the death of his friend. The controversy was futile as well as unpleasant, for it is quite possible to regard Willughby as a pioneer ornithologist without deriding Ray as an "amiable and gentle" botanist. As Dr. Raven points out, there is ample evidence that Ray was "a scientist of genius" and Willughby "a brilliantly talented amateur".

In an eloquent tribute to Ray's "fascinating and heroic personality" Dr. Raven writes of him as "The blacksmith's son who in an age of almost feudal class-consciousness won for himself reverence and friendship and that without sycophancy or aggressiveness; the fellow of Trinity who when consciences were elastic gave up everything sooner than declare that the Covenant which he had not subscribed was no oath . . . the writer who in the last twenty years of his life, straitened in means and racked with pain, produced some fifteen new books, including the 3,000 folio pages of the 'History of Plants', the 'Synopses' of animals, reptiles, birds and fishes, the first serious treatises on science and religion and in addition some nine revised editions of these and earlier works; the naturalist who, in the last decade of the century, with the help of his four little daughters bred and described the life cycle of nearly three hundred local lepidoptera."

Dr. Raven says of Gunther's volume of "Further Correspondence" that it is "marred by some carelessness in editing". The present writer's consciousness that he must take to himself a share in this reproof has perhaps sharpened his perception of some very minor blemishes in a book which he has read with great pleasure and admiration. Why does Dr. Raven say of Dale's "Life of Ray" which Gunther published from a manuscript found in the Bodleian, "Dr. Gunther was apparently not aware that it had been printed before"? Gunther explicitly says "Dr. Andrew Clark printed it some ten years ago in the 'Essex Review'". The slip of "have" for "had" in the sentence quoted about the middle of p. 64 would not deserve mention if it were not that the context makes the tense tragically important.

W. T. Calman.

THE ART OF GLASS POLISHING

Prism and Lens Making

A Text Book for Optical Glassworkers. By F. Twyman. Pp. iv+178. (London: Adam Hilger, Ltd., 1942.) 15*s.* net.

The literature relating to modern methods of glass grinding and polishing is scanty, perhaps because this is traditionally a hand craft, differing little in essentials from the practice of three hundred years ago, and each worker guards jealously the methods handed down to him as valuable professional secrets. Though machines for glass polishing were projected by Descartes and others, there is no record of these being successful until Lord Rosse constructed the machine for making his large astronomical reflectors; this reciprocated the polisher on the revolving work and seems to have standardized this stroke, regarded as the only one satisfactory for accurate 'figuring' until the late Mr. W. Taylor, twenty-nine years ago, showed the feasibility of the more efficient round-stroke machine.

The book under review is distinctive as being written by the managing director of one of the best-known English optical firms, whose work is justly world-famous for scientific precision. Moreover, the firm has developed quantity production of optical elements to serve the needs of Great Britain in two wars, so that experience in two directions, quality and quantity, is embodied. The author specifically limits himself to the methods in use at Adam Hilger, Ltd., and this limitation constitutes both the strength and the weakness of the book; on one hand, because actual working methods are described by one who is familiar with them; on the other hand, the scope of one firm's work is necessarily restricted and methods which are admirably adapted to its own work may not invariably be best for other classes of work. The machines and technique of other firms are scarcely recognized. For example, the trepanning of glass to produce lens blanks is not alluded to, and it is assumed that lens surfaces are polished, and the edges ground, by machines which reciprocate the work across the tool. The author, in the disarming words of the preface, disclaims superiority for his own methods and "hopes that those manufacturers who may be using other, and perhaps better, methods may be willing to give me the benefit of a full knowledge of them"; but Mr. W. Taylor has already published descriptions of his own machines.

The layman who learns that an optical surface can be made to an accuracy of a millionth of an inch, or that two surfaces can be made with the angle between them accurate to a second of arc, is impressed. He is puzzled when he finds that the dimensions of optical elements cannot easily be guaranteed to the same accuracy as machined parts. In fact, the optician is content with thousandths of an inch where the engineer talks of ten-thousandths. Mr. Twyman explains how the accuracy of surface and angle can be attained and tested, but is less definite in explaining the limiting factors in working optical elements to size. In fact, the book is weak on the subject of dimensioning.

The manufacturer, for whom the work is primarily intended, will be particularly grateful for the information on materials, especially for the figures relating to pitch. Strangely enough, no poet has risen to sing the wonders of pitch, the optical worker's most valuable ally. It is the basis of his polishing operation and the means by which he holds his work, retaining it firmly without rigidity and releasing it quickly and cleanly when required, without scratching the delicate polished surface. By its colour it forms the perfect background for the examination for polish and for testing by Newton's rings. The old-time worker gauged its quality by a sort of Brinell test: the constant temperature chamber was his mouth and the Brinell ball his teeth! Mr. Twyman more scientifically measures the rate of penetration of a loaded blunt needle, and gives figures for the different pitches and Canada balsams he finds suitable. As illustrative of the differences of opinion prevalent, Dr. Preston and Colonel Crompton considered this procedure untrustworthy; the former prefers a loaded ball while Dr. J. W. French uses a disk There is thus unfortunately no correlation between the figures given by these different workers.

Undoubtedly the section of the book that will command most attention is that devoted to the working of flats and prisms. Here Hilger's authority is unquestioned. Many of the jigs described are of Mr Twyman's invention. The method of holding the roof prisms so that the angle can be tested in working is particularly ingenious, and so is the polishing machine for making single flats of high accuracy. It is interesting to note the use of the flexed rod for applying pressure, a device shown in Zahn's "Oculis Artificialis" of 1685. Hilger's use it to apply local corrective pressure.

Another section of great importance is that devoted to the testing of optical work. The author is chiefly concerned with the accuracy of flat surfaces and of parallelism or angle between two surfaces. The interferometer and other instrument developed mainly by the author and his co-workers for this purpose are fully dealt with, and so great is the author's belief in scientific methods (and faith in his workmen) that "every optician in the Hilger workshops has free access to these instruments", for "entirely unskilled boys and girls can in a week or two be taught not only to test prisms and lenses . . . but to correct the optical performance by retouching the surfaces". It is to be hoped that the author will "retouch" this last statement when he realizes its implications, for there would surely seem to be no excuse for the slightest imperfections in camera lenses or microscope objectives, and the favourite disclaimer of the optical writer that no optical system is perfect will be untrue.

The work is enriched by historical notes, a bibliography and an index. Misprints are few and unimportant (except the misspelling of Dr. Burch's name) and the most serious omissions from the bibliography are W. Taylor's presidential address to the Institute of Mechanical Engineers, 1932, and W. Ewald's "Die Optische Werkstatt".

In a review criticism is necessarily prominent, but it would be misleading the reader to leave him with any other impression than that the defects of Mr. Twyman's book are slight in comparison with its merits, which should ensure it a hearty welcome from manufacturers and workers and all interested in the fascinating subject of glass working; it is also a valuable contribution to the war effort.

H. W. LEE.

AERIAL PHOTOGRAPHY AND GEOLOGY

Aerial Photographs

Their Use and Interpretation. By A. J. Eardley. (Harper's Geoscience Series.) Pp. xii+203+46 plates. (New York and London: Harper and Brothers, 1942.) 2.75 dollars.

WITH the frequent publication of aerial photographs, usually of some sector of enemy territory, the military value of such photographs is generally appreciated. But aerial photographs have been used for many other purposes since they were first introduced more than eighty years ago. In themselves detailed though rather distorted maps, they can form the basis of the preparation of detailed topographical maps, and even of the refined maps needed for some engineering projects. Aerial photographs have also been used for the determination of the distribution of crops, for making forest inventories, and for various geological purposes. Further applications have been made in studying marsh ecology, and silting and soil erosion. Apart from their many uses, aerial photographs have other valuable features which are emphasized especially with regard to those taken over enemy territory, for they provide information about regions difficult of access far more quickly and, in many respects, in much greater detail, than could be obtained by ground methods in a reasonable time and at a reasonable cost.

"Aerial Photographs: their Use and Interpretation", a revised edition of "Interpretation of Geologic Maps and Aerial Photographs" by A. J. Eardley, deals mainly with the geological applications of aerial photographs. Eardley writes clearly and simply, so that no preliminary knowledge of aerial photography is required before reading his book. Cameras, flying technique, types of photographs, scale determination, and the limitations and the stereoscopic examination of aerial photographs are briefly described in the introductory chapters, which contain much of the basic material found in the U.S. Army field manuals on the use and interpretation of aerial photographs. Only a brief reference is made to photogrammetry, which is a matter for the expert equipped with elaborate instruments; but the simple instruments and methods whereby contoured maps of a small area covered by a few prints may be prepared might well have been more fully described, for the author notes that at times it may be necessary to produce such maps without expert aid. There is a short description of the technique of stereo-sketching, and a fairly detailed discussion of the compilation of mosaics, from which discussion the method of drawing maps without contours may be deduced.

Patterns of outcrop, photographic guides for tracing contacts, and structure, contour and cross-section construction are the broad headings under which the geological interpretation of aerial photographs is considered. There are also short chapters on oblique photographs for reconnaissance mapping, on the interpretation of culture, and on tactical (military) interpretation. The text is supplemented by forty-four excellent aerial photographs (verticals, mosaics, multi-lens composites and obliques, printed like the rest of the book on good quality paper) which show what a valuable aid aerial photographs can be to ground-work under favourable conditions, and how they may give great detail as well as bring out features that may not be observable on the ground or that may become apparent only as a result of prolonged investigation. A further forty-eight figures are included, among them many diagrams showing the outcrops of an area, first as a map and then as the corresponding block diagram.

Geologists and others will be deeply interested in the aerial photographs and in the accompanying discussion. In particular, the thoughtful consideration of Eardley's remarks on structural geology may be recommended to all geology students, for the ability to "restore the strata step by step, if only hypothetically, to their original position of deposition" by logical steps, thereby making an interpretation which "is at least a logical possibility", must be sought by all who would elucidate the structure and geological history of an area.

The aerial photographs of this book were selected to "show clearly the features used in geologic interpretation", and therefore they may "give an exaggerated impression of their value in geologic work. Photographs of many areas will reveal little of interpretative value, and in other areas only faint clues of geologic features may be recognized. However, photographs of such areas are very valuable when taken into the field and used as base maps for charting the geologic rock formation and land forms." While remembering the limitations of aerial photographs and that the photographs reproduced in this book have been specially selected, geologist readers in Great Britain, and, indeed, others also, may well be excused envy of their colleagues in the United States, two thirds of which vast country has been photographed from the air. Perhaps it is not too much to hope that photographs taken in war-time photographic flights over Great Britain, and containing geological information, will eventually reach the Geological Survey and Museum, where they would probably be of assistance to this country's official geologists, and might ultimately be made available to other geologists.

A few errors and ambiguous statements occur in the introductory chapters, and some of the marginless photographs have suffered in trimming. Points such as these can easily be corrected in future editions of the book, in connexion with which the inclusion of several stereoscopic pairs of aerial photographs seems to be worthy of consideration. If the photographs take the form of separate plates inserted in a pocket at the end of the book, they should be of considerable value to any reader who has access to a stereoscope or who has constructed a simple stereoscope according to the author's instructions.

G. D. HOBSON.

EDUCATION AS A SCIENTIFIC STUDY

The Study of Education in England

By Prof. F. Clarke. Pp. iv+60. (London: Oxford University Press, 1943.) 2*s*. 6*d*. net.

AS in the War of 1914–18, and indeed at all times of social upheaval, the pamphlet is much in evidence. One of the latest and best is Sir Fred Clarke's pamphlet or 'little book', which goes to the roots of educational reform in Great Britain. His experience, first in England, then for many years at Cape Town and at Montreal, and then as adviser to overseas students at the London Institute of Education, of which he is director, places him in a unique position for surveying the whole vast educational problem (an aspect of the vast social problem) which gradually unrolls itself as this War goes on. His taste does not take the form of writing large books. He prefers the way of the pamphlet and the magazine article, thrown off as occasion arises or as the inspiration comes. But his pamphlets are so packed with matter that they amount to treatises in disguise. The pages of this latest example, "The Study of Education in England", contain more "thought to the square inch" than the reviewer has for some time encountered.

The author's task of advising visitors, chiefly from the United States, the Overseas Dominions and the Colonies, has naturally been extended to others who have taken refuge in this extraordinary little island, which stood undaunted when all the world thought its fate was sealed. They want some light thrown upon the secret of England's greatness, and in particular they want to know all about the educational system under which her young citizens have grown up.

There the author's troubles begin, for instead of a system inquirers seem to find something very much like chaos. They find the most private and exclusive of schools called 'public' schools, and schools which stand before them in solid visibility called 'non-provided'. They find that we ourselves never quite know what we mean by the terms elementary, secondary, cultural, vocational, technical, boarding, private, public, and so on, as applied to schools. They have to learn how deeply all are infected by motives and considerations that are far from being educational. Seeing that education in England is closely bound up with her social structure, they ask for a book in which the story is told, and they are amazed to learn that no such book has ever been written, though (the reviewer would add) there are very good books on the history of schools abstracted from the rest of the social scene. Seeing that English becomes more than ever a world-wide language, they may ask what has been done to simplify the learning of English as a foreign language, and the answer is that nothing has been done except by private effort. If they ask what provision is made for the study of comparative education, the reply is that there is no public provision, that there once existed an excellent department of special inquiries and reports, which was virtually ended, or at least crippled, by an eminent and perhaps an over-zealous Civil servant.

On the other hand, inquirers should be told of valuable work done by the Board of Education in issuing pamphlets and circulars, and by the reports of its Consultative Committee; of the mass of valuable material accumulated by local education authorities, mostly hidden away in their archives; of the research work done in university training departments and training colleges, and in departments of psychology; and of the serious studies of educational problems promoted and financed by voluntary organizations of teachers and social workers. All this is to the good, and most of it points, says the author of this pamphlet, to the crying need of central organizations for educational research, such as already exist in Scotland, Australia, New Zealand, Canada, and South Africa.

In these lands the wheels of progress run with relative smoothness. Why not in England? Why is it that in England the spirit of scientific research in education is conspicuous by its absence, except as a private venture? The reason is that England has relied upon tradition and has not cared for "the critical organising authority of science". That is the lesson she has yet to learn, and it is for the enforcement of that lesson that this pamphlet has been written. "It is, perhaps," says Sir Fred Clarke, "no accident that in England the great strongholds of educational tradition should also have become the entrenched positions of a 'class' interest, a ruling class interest"—a state of affairs which, as he states with obvious claims to authority, "stands out with striking prominence in the eyes of observers who are acquainted with those examples of another English tradition, the United States and the Dominions". In a comparatively trivial sense we talk of our "dual system". The real dual system of English education resides in the fact that for about 10 per cent of the population, selected largely by wealth, we have 'private' or independent schools, not forming part of the State system, which has produced the great majority of the holders of key positions in Church and State, whereas for the vast majority there is the 'State' system as it has evolved since 1902. Sir Fred devoutly hopes that the two will not be left to fight it out, since the result either way could only be disastrous to national education as a whole. He is far from joining in any attack on the public schools. His anxiety is lest the exclusive and separatist attitude of the minority section may prove to have endangered the tradition itself, including its most valuable elements. The easy-going reliance upon tradition must be abandoned, and along with it must go that lack of interest in serious studies on the part of those who have the control of national education, that startling ignorance in high places of the conditions under which the great mass of the people of England are educated, and that "double-mindedness" that is "induced in a dominant minority which, in defending a concept of education, is also defending a social stratification closely bound up with it".

The author wisely refrains at this stage from attempting to draw up a detailed programme for action. He does, however, indicate the broad conditions which any organized scheme for the study of education in England will have to fulfil, and in doing so he has in mind not only the needs of England herself, but also the wide variety of cultural and social conditions amid which the ideas shaped in English conditions will have to be adopted and interpreted.

To one who has lived through the last six or seven decades, who has seen at close quarters how the State system of education has been administered and supervised by men who relied upon their prestige and their own tradition, and who regarded the pretensions of the psychologist and even the sociologist with a disdainful smile, this call for clear thinking, for the scientific approach, and for ending the period of well-meaning muddling through, is indeed refreshing.

T. Raymont.

BRITISH AND VIENNESE MEDICAL SCHOOLS

British Medicine and the Vienna School

Contacts and Parallels. By Dr. Max Neuburger. Pp. 134+13 plates. (London: William Heinemann (Medical Books), Ltd., 1943.) 10*s*. 6*d*. net.

In his preface Prof. M. Neuburger remarks that though an intensive study has been made of the history of the medical faculty of Vienna and its connexion with the medical schools of Padua, Leyden, Paris and Germany, a similar work on the correlation of the Vienna and British medical schools had been lacking. He has therefore undertaken to remedy this omission, inspired by the affection for his *alma mater* and his admiration for the pioneer achievements of British investigators and physicians. The period covered by the book extends from the middle of the eighteenth century, in which the chief medical men in Vienna were van Swieten and De Haen, who were both followers of Sydenham, and in Great Britain Fothergill, Lettsom and Willan, down to the first quarter of the present century, in which the most notable figures were Nothnagel, Wenkebach, Pirquet and Freud in Vienna, while Hughlings Jackson, Osler and Clifford Allbutt were the most outstanding physicians in Great Britain.

Relations between the two countries were mainly established by visits of British physicians to Vienna and of Viennese physicians to London and other parts of Great Britain, as well as by translations of medical works into English or German. The most notable British visitor to Vienna was Richard Bright, who in 1818 published the "Travels from Vienna through Lower Hungary with some Remarks on the State of Vienna during the Congress" (1814), in which he gives an account of the celebrated "Allgemeines Krankenhaus" and university museums of Vienna.

About the same time William Mackenzie, the famous ophthalmologist, spoke highly of the arrangement of the clinics for internal diseases, diseases of the eye, and obstetrical departments which he had inspected. About twenty years later William Wilde of Dublin, equally celebrated as an ophthalmologist and otologist, in his work on "Austria, its Literary, Scientific and Medical Institutions" (1843), gave an account of the departments of morbid anatomy, of which Rokitansky was the director, of ophthalmic surgery and diseases of the chest directed by Skoda. During his honeymoon in 1856, Lister spent three and a quarter hours with Prof. Rokitansky, whom he described as the most eminent pathologist in the world.

In 1874 Felix Semon, who received his special training in otolaryngology in Vienna, spoke of the postgraduate courses there as exemplary. Osler about the same time also paid a visit to Vienna, where he attended the clinics of Hebra the dermatologist, Widerhofer the pædiatrist, Politzer the otologist, Brava the obstetrician and Billroth the surgeon. Thirty-four years later he returned to Vienna on the occasion of a medical congress.

On the other hand, the principal Viennese medical men who visited London were Josef Frank, the chief physician to the "Allgemeines Krankenhaus", Hebra the dermatologist, Arneth the obstetrician, Beigel the gynæcologist, Politzer the otologist and Hajek the laryngologist.

As regards translations of Viennese writers, special mention must be made of the publications of the Sydenham Society (1843–57) and the New Sydenham Society (1859–1907), which included translations of von Feuchterleben's "Principles of Medical Psychology" (1847), Rokitansky's "Morbid Anatomy" (1849–52), Prochaska's "Functions of the Nervous System and Unzer's Principles of Physiology" (1851), Hebra's "Diseases of the Skin" (1866–80), Stricker's "Human and Comparative Histology" (1870–73), Billroth's "Surgical Pathology" (1877–78), Salzer's "Healing-in of Foreign Bodies" (1894), Neumann's "Pemphigus Vegetans" (1897), Sternberg's "Acromegaly" (1899) and von Lembeck's "Clinical Pathology of the Blood" (1901). Other translations into English of works by eminent Viennese physicians were Plenck's "New and Easy Method of Giving Mercury to those Affected with the Venereal Diseases" (1767), Skoda's classical "Treatise on Auscultation and Percussion" (1853), Türck's "Clinical Research on Different Diseases of the Larynx, Trachea and Pharynx" (1863), Stellwag's "Text-book of Practical Ophthalmology" (1868), and Zeissl's "Outlines of the Pathology and Treatment of Syphilis and Allied Venereal Diseases" (1886).

Translations of outstanding works by British writers into German included Mason Good's "Diseases of Prisons and Poorhouses" (1799), John Thomson's "Lectures on Inflammation" (1814), Hodgson's "Treatise on the Diseases of the Arteries and Veins" (1815), Christian's "Granular Degeneration of the Kidneys" (1839), J. R. Bennett's "Causes, Diagnosis and Treatment of Acute Hydrocephalus" (1844), Forbes' "Homœopathy" (1846), Ferrier's "Functions of the Brain" (1879), Morell Mackenzie's "Diseases of the Throat and Nose" (1880) and Braid's "Neurypnology" (1881).

Prof. Neuburger is to be congratulated not only on his admirable survey but also on his mastery of English. The text is interspersed with portraits of van Swieten and De Haen, Maximilian Stoll, Johann Peter Frank, Lucas Johann Boer, Richard Bright, Rokitansky, Skode, Sir William Wilde, Hebra, Semelweiss, Osler, and an engraving of the Allgemeines Krankenhaus. A short bibliography of English and German works is appended. There is no index, but this is in some degree compensated for by a table of contents and is possibly attributable to the paper shortage.

J. D. Rolleston.

THE FLORA OF BOMBED AREAS*

By PROF. E. J. SALISBURY, C.B.E., F.R.S.

THE vegetation which develops spontaneously on the derelict bombed areas clearly provides us with a means of assessing the efficiency of the diverse methods of dispersal of the constituent species. But in utilizing their study for this purpose several factors must be taken into account.

Many such areas present ruined houses of such a character that there is little or no exposed soil upon which plants can grow. The activities of demolition squads or reconstruction labourers may partially or entirely preclude the possibility of plant growth. Hence the poverty of the flora on many sites cannot be adjudged as evidence of inefficient dispersal.

In general, the most diverse floras in the London area are to be met with towards the west, and there tends to be a diminished diversity of species as we pass eastwards towards the City. This trend can doubtless be attributed in part to the direction of the prevailing winds but also in some measure to the increasing frequency and size of gardens in the West End which provide sources of weed and other seeds.

In determining the variety of the flora, the efficiency of the dispersal mechanism exerts the major role in determining the range of occurrence in suitable habitats. The number of the areas examined in which any particular species has been observed, that is, its frequency, will be used to give us an approximate measure of the efficiency of its dispersal. The number of individuals of a particular kind on any one area, that is the abundance on a site, may also be an indication of efficiency of dispersal or merely of subsequent spread.

After the great fire of London in 1666, it is recorded by Ray that the ruins around St. Paul's were abundantly colonized by the London rocket (*Sisymbrium Irio*), but 150 years later the plant would appear to have become a rare plant and I have entirely failed to find a specimen on any of the sites examined. Of all the plants of our bombed areas the most frequent, though often not the most abundant in the early stages of colonization, is the rosebay willowherb (*Epilobium angustifolium*), a plant we often associate with burnt areas on heaths. The greater frequency of heath fires which accompanied the advent of the motor-car and the growth of cigarette smoking is probably in large part responsible for the rapid spread of this wild flower in recent years. In Hertfordshire, for example, the rosebay willowherb was a scarce plant half a century ago whereas it is now common throughout the county, and a similar change has taken place south and west of London also. Thus there are to-day sources of seed supply all around the Metropolis.

The association of the rosebay willowherb with burnt areas is probably due to a variety of causes among which, not the least important, is that its seeds only germinate freely in well-illuminated areas, and the occurrence of a fire usually ensures freedom from shade.

Secondly, soil which has been subjected to heat is known to be somewhat toxic to many plants until after the lapse of some weeks when, through oxidation, the deleterious chemical substances have been rendered innocuous. But some plants, notably certain mosses such as *Ceratodon purpureum*, and *Funaria hygrometrica*, the liverwort *Marchantia polymorpha* and the rosebay willowherb, are especially tolerant of such conditions and are all striking and characteristic features of the 'old hearths' in the West of England woodlands where charcoal-burning is still carried on. These plants can therefore develop before the soil becomes sufficiently favourable for other competitors to flourish.

Again, growth of the willowherb is markedly stimulated by nitrates, and the production of these may be promoted by burning in two ways; first by the fertilizing action of the ash constituents, which also stimulate the growth of the willowherb directly, and secondly, by the partial sterilization of the soil. That it is such indirect effects, rather than direct effects, of the fires which favour the willowherb's growth is indicated by the abundance and frequency which it exhibits on woodland clearings where similar soil changes accompany the sudden access of light.

A relatively small plant of rosebay willowherb will produce two hundred seed-pods each of which may contain nearly four hundred seeds, so that a young plant might well yield about eighty thousand seeds in a single season, while the yield of a large adult individual would far exceed that figure. Each seed is about a millimetre in length and bears some seventy long silky hairs forming an effective parachute which opens out in dry air but closes when the air is moist. The whole thus forms a beautiful and most efficient aid to dispersal by air currents, which is brought into action under conditions most favourable to the carriage of the seeds.

We can, therefore, scarcely be surprised that the rosebay willowherb is one of the first flowering plants to appear on bombed sites or that it should have been found on nearly ninety per cent of those examined. Owing to its spread by means of underground shoots, it tends to form dense patches which may extend over a yard in a season, and this feature, combined with the height it can attain and its perennial character, render the plant a successful competitor against other species, and quite commonly, where established some time, it becomes the dominant type. But when Curtis wrote his famous "Flora Londiniensis" nearly 170 years ago, the species was evidently only a garden escape in the London area and still infrequent a century later.

Second in importance both as to frequency and abundance is the common groundsel (*Senecio vulgaris*). The average seed production is much lower than that of the willowherb, numbering about 1,100 potential offspring per plant; moreover the groundsel is much shorter and an annual. In addition to their dispersal by wind, the fruits become sticky when moist, owing to which they are liable to be carried on the boots of pedestrians and the feet of birds. But the rather small output per plant is compensated by the fact that several generations of plants ripen their fruits in a favourable season, and unlike those of some of its congeners the fruits will germinate at almost any time of the year when the temperature is favourable.

Two other members of the genus Senecio are conspicuous and common features of bombed sites, and both have an interesting history. The commoner of these, found on 56 per cent of the areas, is the so-called Oxford ragwort (*Senecio squalidus*), a native of Sicily, which in its native home frequents volcanic ashes, so may well find the site of a burnt-out building a congenial habitat. The first record for Great

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* Substance of a Friday Evening Discourse at the Royal Institution on February 19.

Britain is at Oxford in 1794. There Sir Joseph Banks noted the plant as growing plentifully on the walls and in and about the city. Cultivated specimens are in Bobart's herbarium, so that there can be little doubt it was grown in the Botanical Gardens at Oxford and thence escaped to become naturalized in the neighbourhood. But though we next hear of the plant in Berkshire, the other counties to which it spread during the nineteenth century were not the contiguous ones, but north Devon (1835), Worcestershire (1836), west Suffolk (1849), east Kent (1875), Buckinghamshire (1897), and west Sussex (1898). At the present time the Oxford ragwort is to be found in approximately 62 per cent of the English counties as well as to a limited extent in Ireland and Scotland. In London the Oxford ragwort was first recorded in 1867. The greater prevalence towards the south is in accord with the plant's Mediterranean origin.

The fruits of the Oxford ragwort are larger and heavier than those of the groundsel and less readily carried by the wind. An average-sized plant will probably produce between fifteen and twenty thousand fruits as compared with the 1,100 of the groundsel. Still, if the latter produced two generations only in a year, compared with the one of the Oxford ragwort, the potential offspring at the end of the season would be well over a million. Some of the fruits of the Oxford ragwort may germinate in the autumn, but the majority would appear to germinate in the spring.

The sticky groundsel (*Senecio viscosus*), which was found on 45 per cent of the sites, is easily distinguished from the common groundsel by the much larger size to which it can attain and by the covering of sticky glandular hairs. The chief home of the species is southern Europe, and it is perhaps native as far north as Belgium. It is probably an introduction to Great Britain, although some botanists have claimed the species as native to certain coastal districts. The sticky groundsel was first recorded as growing in Great Britain by Ray in 1666, from banks in the Isle of Ely, but, despite its possible sojourn in England of nearly three hundred years, only during the past twenty-five years has the rate of spread of the sticky groundsel been rapid. Thus in 1915 the number of counties in which the species had been recorded was only slightly larger than in 1900, though it should be noted that these embraced additional areas far removed from the main southern group. Between 1915 and 1940, however, this groundsel had been recorded in no less than fifty-two of the seventy-one English counties and vice-counties and from twenty-seven of the forty in Scotland.

As a casual the sticky groundsel was found near the Caledonian Hospital in 1838 and de Crespigny records its occurrence near Kensington Railway Station in 1887. Now it is to be found on nearly half the derelict sites, and on some of these it is common or even abundant.

Each head produces an average of about seventy-three fruits, whilst the number of fruit-heads per plant is about eighty-four. Hence the normal production of fruits by a single plant would be about six thousand. But one very large plant, on which the fruiting heads were counted, had produced no less than 1,196, or an output of approximately eighty-six thousand fruits.

Despite the southern provenance of the sticky groundsel it is comparatively hardy, and I have found plants still flowering after spells of frost when the temperature fell to 23° F.

Another very common and frequent plant on our sites is the coltsfoot (*Tussilago Farfara*). Here the fruits are very small and bear a silky parachute of hairs which ensures wide dispersal; moreover, as with the rosebay willowherb, there is rapid vegetative spread which accounts for the large colonies that it soon forms.

The coltsfoot is very tolerant of heavy clay soils and has always been a feature of vacant sites in the suburbs, where mortar rubble remedies the deficiency of calcium in the London clay. The early ripening of the fruits enables the seedlings to pre-empt a place in the sun before the arrival of competitors. Each head may produce some 300 fruits, and as many as twenty or thirty heads may occur in a tuft, representing a possible output of between 6,000 and 9,000 fruits.

The seedling will form inflorescence buds in the autumn of the first year and these flower the following spring, whilst other axillary buds develop as rhizomes at the ends of which additional rosettes of leaves and tufts of flowers are formed. By means of these underground shoots, which may attain to a length of thirty inches, a large area can soon become occupied by the leafy rosettes, whilst the connecting rhizomes between them die and decay in about three years after their formation. From these facts it will be appreciated why the coltsfoot is so efficient a colonizer and so pernicious a weed.

Another plant, which though present on only about 40 per cent of the areas examined, is normally abundant where it does occur, is the Canadian fleabane (*Erigeron Canadensis*).

The history of this North American species would appear, so far as Europe is concerned, to begin about 275 years ago when, according to tradition, it appeared on the Continent from seeds which had dropped out of the stuffed skin of a bird. For Great Britain, the first record appears to be one from the London area some twenty years later. In 1836 it occurred on old walls at Chelsea, at Hampton Court and elsewhere, whilst by the time de Crespigny wrote his "New London Flora" in 1877 the Canadian fleabane was frequent on waste ground in London and especially on the railway embankments that had been constructed, as an outcome of the new means of transport developed during the early 'forties of the last century.

By the end of the nineteenth century the plant was established as an alien weed of waste places in some ten counties south of the line from the Bristol Channel to the Wash. Now it is to be encountered in most of the English counties south of Yorkshire, in a few of the Welsh counties as well as in the south-eastern parts of Scotland.

The seeds germinate in the autumn and pass the winter as rosettes which send up a flowering stem in the following summer. A large plant was found to bear about 6,500 flower-heads, and the average is well over seven hundred. The number of fruits which each head produces is about thirty-five. Each fruit is small and flattened, about a millimetre in length, and bears at the tip a parachute of some twenty-five toothed hairs.

Kerner von Marilaun estimated that an average plant would produce 120,000 fruits, and the large plant just referred to would have yielded about 233,000 fruits. It will be apparent, therefore, that the production of fruits by the crops of plants such as we see occupying some of the bombed sites must be prodigious.

Other common members of the same family on the bombed sites are the sowthistle (*Sonchus oleraceus*) and the dandelion (*Taraxacum officinale*), but there is one member of this group which, although found on only about 14 per cent of the areas examined, is of particular interest. This is *Galinsoga parviflora*, a native of Peru, that was first recorded as a naturalized plant in England as a garden weed at Richmond in 1860 and two years later from Middlesex. It had originally been cultivated in the Gardens at Kew in 1796, whence it spread to the immediate surroundings.

The fruits from one head are of two types. The small number of white ray-florets produce fruits which are larger than those produced from the central flowers, and each has at its summit five or six short feathery processes which represent the pappus, though far too small in relation to the size and weight of the fruit to ensure dispersal by wind. The yellow tubular flowers, which occupy the central area of the flower-head and number between 10 and 30, produce much smaller fruits. Each of these disk fruits bears a parachute of narrow elliptical, almost petal-like, processes fringed with hairs which facilitate the dispersal of these fruits for short distances by the wind. Both types of fruits are beset with a number of short bristle-like hairs which tend to make them cling readily to rough surfaces, while the flattened form of the fruits facilitates retention. It is perhaps due to this that transport by human agency may occur also.

The larger ray-fruits would appear to be more efficient as a means of ensuring the persistence of the species once it has reached a locality, whereas the smaller fruits, though more susceptible to adverse conditions, are better suited for transport to a distance and thus for the evasion of competition. A moderate-sized plant of Galinsoga will produce about four thousand fruits.

As we might anticipate, several grasses are common on the bombed sites, and of these *Poa annua* is the most abundant, whilst *Lolium perenne*, *Agrostis alba* and *Holcus lanatus* are widely distributed. The presence of these, together with *Dactylis glomerata*, *Poa pratensis*, and also, though more rarely, of oats and wheat, suggests their origin from seeds escaping from the nosebags of horses. To this source also can probably be attributed the frequent presence of red and white clovers (*Trifolium pratense* and *T. repens*), the former on about one quarter of the bombed areas.

Chickweed (*Stellaria media*), though widespread, is by no means everywhere, and this is probably an outcome of the mode of dispersal. The seeds of the chickweed become sticky when moist, and as a consequence are frequently carried on boots or less commonly on the feet of birds. This is true also of the seeds of the ribwort (*Plantago major*), which become mucilaginous when wet. Hence, as we might anticipate, it is especially on those areas where pedestrians can enter with ease that the species just mentioned most commonly occur.

Of the large number of bombed sites examined, many have yielded only a few species, but the total list recorded numbers ninety-five vascular plants. In this assessment no areas have been included which were in part the sites of former gardens, but only such as might reasonably be assumed to have been previously unoccupied by vegetation. The only exception to this generalization is where the species already present were known, so that the new arrivals could be identified.

It is evident from a study of all the species which have been recorded from these sites that wind carriage is by far the most important means by which the seeds and fruits are introduced. The species which are dispersed in this manner comprise 30 per cent of the total. Moreover, if we confine our attention to those species growing on more than one quarter of all the sites, we find that eight of these are dispersed by the wind and only four are dispersed by other methods. Further, the members of the Compositæ which have a parachute mechanism upon their fruits are among the commonest species present, while other members of the same family which do not develop such a pappus, as, for example, the yarrow (*Achillea millefolium*), the mugwort (*Artemesia vulgaris*), the scentless mayweed (*Matricaria inodora*), and the nipplewort (*Lapsana communis*), all occur on only a small proportion of the sites examined, and the pineapple weed (*Matricacia suaveolens*), which has spread so rapidly in recent years, is quite a rare plant.

It is interesting also, in this connexion, that the only garden plant met with on several sites is the purple Buddleia (*Buddleia variabilis*), sometimes in appreciable numbers at considerable distances from possible sources of seed. The ripe capsule contains a number of very light seeds in which the body is minute whereas the seed coat is extended as a flattened wing at each end.

The widespread rosebay willowherb, as previously stated, has plumed seeds and it shares with the plume-fruited groundsel the distinction of being the commonest species. The only other species on these sites with plumed seeds are two species of willowherb, which are both infrequent (*Epilobium montanum* and *Ep. hirsutum*), and the goat willow (*Salix caprea*). Seedlings of the latter tree have been seen on 16 per cent of the areas studied.

In view of the relative inaccessibility of many of the bombed sites, it is scarcely surprising that those species which depend to any appreciable extent for dispersal by carriage on the boots or clothing of pedestrians are generally somewhat infrequent. One might perhaps have expected bird dispersal to be an important means of introduction, were it not for the character of many bombed sites, which may well make them rather unattractive to birds until such time as vegetation has rendered them a source of food.

Elder bush seedlings (*Sambucus nigra*) and the woody and black nightshades (*Solanum dulcamara* and *S. nigrum*) probably owe their presence to this mode of introduction, but the more frequent occurrence of tomato seedlings is, one suspects, a result of human dispersal. Nevertheless, though the species which are probably dispersed mainly by birds are often quite infrequent, they are the next in importance as regards the number of kinds involved, since they comprise 20 per cent of the total. Of the remaining species, probably 14 per cent are mainly dispersed by human agency, leaving some 34 per cent for which the main agent of dispersal is uncertain.

It is evident then that the immigration of these plants is due mainly to the transport of their seeds or fruits by air currents. Some of the seeds, like the spores of the ferns, are so small as to behave like dust particles ; other seeds and fruits present a large surface in proportion to their weight, and this is especially true of those which bear a parachute of hairs.

But observation and experiment show that most of the fruits and seeds shed from a plant do, in fact, fall to earth at no great distance from their point of origin. The common ragwort (*Senecio Jacobaea*), though uncommon on the bombed sites, may serve as an example, since the dispersal of its plumed fruits was studied under natural conditions in New Zealand by Poole and Cairns. Trays were placed at intervals along lines radiating from a group of fruiting plants, and the numbers shed at the different distances were counted. The radiating lines of trays were evenly spaced with respect to the points of the compass, and though more fruits attained the longer distances before coming to earth when travelling in the direction of the prevailing wind than in the reverse direction, the vast majority of the fruits fell within a circle 180 ft. in diameter, with the parent individuals occupying an asymetrical position 120 ft. from the circumference before the wind and 60 ft. to windward. My own experiments with poppies, using an artificial wind created by means of a fan (cf., "The Reproductive Capacity of Plants". Bell, 1942), show the same feature in an accentuated form with the slight difference that since the seeds are here jerked out of the capsule pores, by the action of the artificial gusts of wind on the stiff stalk of the fruits, the maximum fall of seeds was 20–40 in. away from the capsules, not immediately around their base. That this is true also for natural conditions is indicated by field studies on the mullein, where the proportion of seeds attaining varying distances from the parent was estimated from the number of seedlings developing in a uniform habitat. The maximum fall is about 12 ft. from the parent.

Such facts lead us to appreciate that even these highly specialized seeds and fruits fail to attain any great distances by wind action alone, and indeed accounts of wind dispersal have hitherto failed to recognize the fundamental part which is played by upward convection currents in ensuring such dispersal as shall mitigate competition among the offspring.

It has been pointed out by Prof. D. Brunt that, under uniform conditions in still air, if the surface of the soil be heated up by the sunshine, convection cells are formed in which the rising column of heated air ascends for a distance, depending mainly upon the temperature differences involved, and which spreads out and descends at a distance from this rising column approximately equal to the height of the latter. Clearly, a minute seed or a plume fruit caught up in one of these convection currents would be carried up a certain distance and then again brought down at a distance from the parent plant roughly corresponding to the height to which it had attained. The efficacy then will in no small degree turn upon the average height and frequency of such convection currents. I am indebted to Prof. Brunt for the information that convection currents over London might be expected frequently to attain a height of 500 ft., though appreciably greater heights of several thousand feet may sometimes obtain. Their efficacy for dispersal will depend upon the coincidence of the period of ripening of the fruit, commonly early autumn, or late summer, with a period of warm dry weather and sunshine; so, I think we shall agree, that in the English climate it is reasonable to state that very rarely will such conditions coincide with the occurrence of convection currents of more than average altitude.

If no other factor intervened, we might then expect, on the basis of these assumptions, that a species in the London area would spread at a rate of somewhere about a mile in ten years. Actually, we have a rate of advance of this order provided by Galinsoga, which, entering Richmond in 1860, traversed about nine miles in the subsequent eighty-three years, or an average of a mile in rather more than nine years. In windy weather the convection cells of the air are changed in form, but the distance between the upward and downward currents is not appreciably modified. If, however, by a fortunate accident a seed or fruit is carried out of the circulatory air current into the wind current above, it may be carried long distances before again coming to earth.

The larger the surface that the propagule presents relative to its weight, the more chance there is of this happening; hence it is scarcely surprising to find that the rate of spread shown by *Senecio squalidus* and *Senecio viscosus* is not only more rapid but also shows a much more varied rate of extension of its range. For example, the sticky groundsel during the period 1900–15 spread to locations 50–200 miles from the nearest previous habitats, whilst during the next twenty-five years a further discontinuous extension of up to 180 miles was recorded. Species with efficient means of wind dispersal do, in fact, appear to present normally a slow rate of spread around the centres of occupation and also extension to new centres often very remote from the previous stations. These latter may well represent the occasional fruits or seeds which are carried up by convection currents into wind currents that are more than local. If the rate of fall of propagules in still air is determined for different species, their relative efficiency for long-distance carriage can be approximately estimated. It must, however, be realized that the efficiency increases at a more rapid rate than the decrease in the rate of fall.

The following represent averages of a number of determinations in still air of the rate of fall of ripe seeds or fruits of the species concerned and are expressed as the time taken to fall through a distance of 10 ft.

Epilobium angustifolium	33·4 sec.
Senecio vulgaris	10·0 sec.
Buddleia variabilis	5·4 sec.
Senecio viscosus	4·6 sec.
Galinsoga parviflora	3·4 sec.

The rate of fall of the seeds of the rosebay willowherb is seen to be far slower than that of the seeds of Buddleia, but these latter fall more slowly than the fruits of the sticky groundsel or Galinsoga. The individual seeds of the willowherb varied in this respect, probably depending to a great extent upon the development and divergence of the hairs which the seeds bear. One seed fell 10 ft. in 13½ sec., whilst at the other extreme another seed occupied 66 sec. in traversing the same distance. The degree of divergence of the hairs constituting the parachutes of these seeds or fruits is mainly influenced by the humidity of the air, the hairs closing together when the air is damp and diverging more and more as the air becomes drier. It will be apparent that such hygroscopic response not only ensures that the seeds and fruits will tend to be detached from the plant under climatic conditions most favourable for their dispersal, but also that they will tend to come to rest once they have settled on damp soil. It will also be appreciated that the parachute of a seed carried up by a warm convection current of dry air may well exhibit partial closure when it reaches the cooler conditions above, and thus descent down the 'walls' of the 'convection cells' is facilitated.

The facts we have just considered make it apparent that the dispersal mechanisms are in large measure responsible for the high frequency of the rosebay willowherb and the common occurrence of the groundsels. The dust-like spores of the mosses, ferns and fungi, which are commonly encountered on the bombed areas where conditions are favourable to their growth, are almost equally well dispersed, and if any further tribute to the action of upward currents were needed it is furnished by the occurrence of many of the commoner species of these bombed areas on old buildings at considerable heights above the ground.

Actually the order of arrival of the various kinds of plants, though to some extent determined by the nature of the soil and the changes which it undergoes with the passage of time, is in no small degree a measure of the relative efficiency of their means of dispersal.

Dispersal, both throughout the country in general and on the bombed sites in particular, is found to be a dual process—a short-distance dispersal which is more or less continuous in space, and a long-distance dispersal which is strikingly discontinuous and, being dependent upon the coincidence of favourable circumstances, somewhat erratic in its incidence.

Discontinuity, which has always been regarded by biologists as a sign of antiquity, is thus seen to be also an attribute of youth. Where the efficiency of dispersal is low, contiguity of occupation will preponderate, but where favourable environmental conditions are infrequent and dispersal efficient, discontinuity may tend to persist.

FUNCTION AND FUTURE OF UNIVERSITIES

MORE than one organization is discussing the post-war development of university education. A committee of the British Association on post-war university education has been at work on this problem for more than a year and has already published an interim report (NATURE, 150, 716; 1942), and the Association of University Teachers is also discussing a draft report of a committee which has been considering the future developments of university education. It was a happy inspiration, therefore, which caused the Association of Professors and Lecturers of Allied Countries in Great Britain to arrange for a conference at which they could discuss with their British colleagues both the fundamental question of "The Function of a University in a Modern Community" and the equally vital problem of "Methods of Practical Co-operation between Allied Universities in the Future". The conference was held on April 10, by kind permission, in the rooms of the Royal Institution.

Prof. A. L. Goodhart (United States), who presided at the conference, in his opening remarks dwelt on the fact that a reconstruction of the world after the War, if we are to have a permanent peace, must have an intellectual and a moral basis. The purpose of a university is the establishment of truth, but it is not enough to establish truth 'in an ivory tower'. Universities have an active and not a passive part to play in the modern community. We must also realize that education must not stop with youth; it is a life-long function which can never end. Here again the universities can play a leading part by taking charge of adult education, which means the education of the community.

Sir Richard Livingstone expressed the opinion that the modern university has not shown any direct influence on the spiritual and moral life of the world; no influence comparable to that of the University of Paris in the thirteenth and fourteenth centuries, of the English universities in preparing the English Reformation, or of Fichte and others in the early nineteenth century. They have not helped the democracies to create any countervailing philosophy to the teaching of Nazism. They have given the world the guidance it needed in science, economics and sociology, but not in the knowledge of good and evil. Hence they have failed to help civilization where it most needs help. They send into life men who are good political technicians but poor statesmen. The universities should demand of all their students that, in addition to their main subjects of study, they should attend courses in three subjects which are a part of the indispensable equipment of educated men—the influence of science on civilization, religion and philosophy, and so learn something of the fundamental problems of life.

This important aspect of university teaching, so essential for the understanding and future maintenance of peace, was dwelt upon by several subsequent speakers. The evils of the absence of instruction in the fundamental problems of life were stressed by the Minister of Education for Poland, Prof. St. Kot. Magnificent education and technical proficiency obtained without acquiring a knowledge of religion and philosophy are liable to be devoted to the service of evil causes. It is the youth of the universities that fill the ranks of the fanatics—marching, beating up their opponents and terrorizing democratic elements.

The Yugoslav Minister of Education, M. Trifunovitch, in considering the functions of a university, indicated that it may vary somewhat according to the community. In a large and rich country, it might be possible to train considerable numbers of scientific workers, but in a young peasant State like Yugoslavia, it is a luxury and threatens to produce an intellectual and unemployed proletariat. The universities should train the young men, the living force of their nation, to collaborate so effectively that the vitality of the nation might be steadily raised and its material and spiritual progress ensured. The preparation of graduates for certain branches of the Civil Service is one of the functions of the Yugoslav universities, but he emphasized the point that the university diploma itself should not open automatically the royal road to certain higher ranks of the Service; the latter should depend on the subsequent acquisition of practical knowledge and experience.

That the universities, apart from the specialized training they give in the sciences and the arts, should also provide the education for the learned professions is a generally accepted thesis. This should include the training of teachers, of whom, however, only about 20 per cent are directly trained by the universities in England and Wales. If provision should have to be made at the universities for all teachers in training, some 30,000 additional students would seek to enter the universities. Mr. P. R. Morris, director of education for Kent, told the conference that "the attitude of the universities towards this great problem will, in no small measure, determine the influence of the universities on the community at large and also their relationship to the educational system". The universities, he said, must inspire the social ideal of the community. To do so they must themselves be part of the very texture of society and not institutions isolated from society as a whole. Their interest in social problems must be disinterested but not detached.

Prof. J. A. Veraart (Netherlands) gave a very suggestive account of the necessary "Social Reconstruction within the Universities". He considers that during the nineteenth century an individualistic mood took possession both of the lecturers and the students, and that it is necessary after the War that they should foster the feeling that teachers and taught belong to one close community. An important part of the time of the professors should be reserved to enable them to take part in scientific and social gatherings of students. As much personal contact as possible should be made between staff and students, who should feel themselves in the midst of a community in which there is an interest in all their needs, scientific, social and cultural. That is the best means of securing the cultural development of the students, which is furthered more by personal contact than by formal instruction.

On the question of "Co-operation between Allied Universities in the Future", which was dealt with in the afternoon sitting of the conference, there was practical unanimity between both British and foreign representatives as to the need for such co-operation. Various suggestions were put forward as to how this could best be done.

Mr. Kenneth Lindsay, M.P., considers that intellectual co-operation of the savants, spasmodic conferences of specialists and the exchange of professors and students, although good in themselves, only touch the fringe of the problem. Previous attempts at its solution failed, not for want of good intentions but by a lack of a common purpose and adequate machinery. He advocated the creation of an international organization comparable with the International Labour Office of the League of Nations. It could for the moment be preceded by a United Nations Office of Education in London during the War, while there are among us so many distinguished Allied professors and lecturers. They had been responsible for organizing the conference and it should not come to an end without arranging for the continuance of some more permanent form of intellectual co-operation.

The International Education Office which Mr. Lindsay envisaged should examine the main principles of existing systems of education and draw up a model Education Charter as a supplement to the Atlantic Charter. He is also of the opinion that there is a strong case for establishing centres for international study of education and for cultural exchange. In this field he welcomed the work of the British Council. Much could be learned from the notable experiment of the School of International Studies held in Geneva between 1924 and 1939.

Prof. S. Glaser pointed out that Dr. Julian Huxley, in an article recently published in the *New Statesman and Nation*, had suggested the creation of such an international organization, a sort of International Education Office, the task of which would be the consideration and realization of a world education programme. Prof. Glaser thinks that the Association of University Professors could render useful service in creating an International University Institute, which might deal with comparative education and could collect and distribute information concerning the universities of different countries, their regulations, their entrance conditions, fees, degrees, living conditions, etc. It might deal with exchanges of teachers and students, recognition of degrees, and lastly with the organization of international university conferences such as have been already initiated by the Association of University Professors in Great Britain.

Prof. Kot, the Minister of Education for Poland, was equally emphatic that the universities of all Europe should join together in an international association, which would define its own tasks and think out methods of fulfilling them. For after the military victory, there would still remain the enemy that had been reared in the minds of the younger generation in the lands of dictatorship. In the re-education which would have to take place, the universities will have to play a leading part, and they should not hesitate to undertake once more the task of general formulation of a world outlook, involving the transformation of minds and character. It will be necessary to rediscover a common tongue and to inculcate common conceptions into the nations, which in this respect have been severed from one another for many centuries.

It might, of course, be questioned whether universities which are State institutions could work harmoniously with universities which, like those of Britain, are independent of the Government even when they receive subsidies from the latter. British universities have been very careful to safeguard their independence, whereas State universities seem more likely to be absorbed into political strife or authoritarian dominance. Prof. Paul Vaucher, however, in an excellent account of the development of French universities since the days of Napoleon, showed how, in spite of being State institutions, they maintained their spiritual and intellectual independence, and that if they can maintain their academic freedom and liberty of mind, they are perhaps better able to play the part and fulfil the duties assigned to universities in modern communities. The two main objectives of the universities are considered by Prof. Vaucher to be: the training of students in acquiring general knowledge and possibly wisdom, and the promotion of the progress of science by independent research.

Prof. E. J. Bigwood, who was so active in Belgium in connexion with the Hoover Relief Committee after the War of 1914–18, indicated that at that time there was a strong feeling that closer personal relations should be encouraged between Belgian intellectuals and their foreign colleagues. When after the War very large funds of the Hoover Relief Committee became available, two important permanent foundations were created and put at the disposal of all Belgian institutions of higher education: the "Fondation Universitaire" in Brussels, and the Belgian American Educational Foundation in New York. More than six post-graduate fellowships were awarded to young Belgians to spend a year in American universities, sometimes renewed for a second year. At the same time, a limited number of similar awards were made to American students to study in Belgium. In addition, there were certain private foundations which sent Belgian students to Paris and to other foreign universities The effect of the visits of such students was considered in Belgium as of the highest importance for promoting good international feeling, and should be arranged between the universities of other countries.

MODERN INDUSTRY IN THE NETHERLANDS EAST INDIES*

By DR. P. H. W. SITSEN
Netherlands Economic Mission, Washington, D.C.

THE evolution of simple existence to prosperity encounters the same problems everywhere. In modern countries the evolution goes from the stage of self-employment via compulsory labour to modern wage employment. Especially in the field of agriculture, where up to the present day self-employment is still in existence at some places, the stage of compulsory labour was in the beginning represented by outright slavery, while in industry in the beginning labour was compulsory and received only meagre wages.

In modern times social legislation, organized labour, modern banking and the gospel of thrift, fostered in the non-capitalistic classes, made it possible to take care of the future and also to give a fair share of the gains of production to the working classes. The first stage—that of self-employment—was a fairly static one; the second—that of compulsory labour—brought a larger increase of income but only to the entrepreneurs, whose wealth and power grew; the third stage—that of modern wage labour—inaugurated a period of prosperity for an ever-increasing part of the whole population.

In the Netherlands East Indies we find the same evolutionary trend; the stage of general self-employment, with only an irrelevant volume of exports, is succeeded by a period of compulsory labour. Under the influence of the entrepreneur class, a large volume of agricultural and mining products was produced and surplus capital was formed in the same manner as this class fulfilled its mission in industry in Western civilization. The labourers received low wages because the greater part of the production was performed as part-time work by the Indonesian farmer, whose bare existence had been protected from the beginning by agricultural laws.

The development followed the same natural course of events as everywhere in the world. The entrepreneurs made a large amount of money and for the greater part this capital was reinvested in new enterprises, paving the way for new possibilities for the future of the people.

The difference from the development in other countries is that the reinvested capital remained mainly in the hands of the Dutch, the British and, later, the Americans. Dividends and interest payments did not affect the purchasing power of the native population but that of absentee investors. This kind of commercial imperialism has certainly been very advantageous for the entrepreneurs. More and more capital went to tropical regions to be invested in the production of raw material. A keen price competition between the raw material countries caused an interruption in the rise of workers' wages, while the power of the entrepreneur class was seriously threatened.

The extent to which the prices were reduced in the Netherlands East Indies during this crisis can be demonstrated by mentioning that an Indonesian rubber grower could get a sewing machine for 40 lb. of rubber in 1913, as against 240 lb. in 1939; a copra-growing farmer could buy a can of salmon for 2 lb. of copra in 1913, while in 1939 he had to pay with 6 lb. of his product; an Indonesian gum-producer could have a piece of cotton goods for 7 lb. of gum in the former year, whereas he had to produce as much as 20 lb. to obtain the same commodity in 1939.

This very disadvantageous rate of exchange caused a difficult situation internally for the Indonesian workers and farmers and loss of capital and energy to the entrepreneurs. It provided for the Indonesian people and its government, however, the opportunity to show how with united forces such difficulties could be overcome. The Indonesian intellectuals, educated in schools of higher learning, took their fate in their own hands with the help of a progressive group of economists. By degrees they were able to influence the Government, which gradually shifted from a guiding and conciliatory position to a form of almost completely directed economy, with the greatest amount of prosperity for the native population as guiding principle. First of all, the formation of capital, thus far mainly for the good of the absentee capitalist, was fostered in the local Indonesian community. As to commercial capital, here the Indonesian stake had already grown to more than nine hundred million guilders and was increasing rapidly.

The production of the commodity industry, organized by Western methods, tripled in this last decade, while nearly a hundred million guilders of invested capital were in Indonesian hands. Wages in industry rose rapidly. In 1940, the average income of factory workers in industries amounted to about 350 guilders a year. A guilder was equivalent to two American dollars.

The above statistical data on development were reached at a time when buyers of the Netherlands East Indies raw materials drew the main profit out of the total production, and entrepreneurs in the Netherlands East Indies lost a large amount of capital. This may seem paradoxical but it is actually very reasonable, and it is of paramount importance for future developments to understand this economic phenomenon. For example, gradually only 568,000 hectares of the total rubber-cultivating area was in the hands of Dutch and foreign investors, while 1,300,000 hectares were owned by the Indonesians. Of the coffee estates, 107,000 hectares were financed by Dutch and foreign capitalists while 123,000 hectares were brought into production by native capital.

Of a total of about 4½ millions of hectares of land producing raw material, not less than about three millions had come into Indonesian hands. This shift of production from European to Indonesian producers caused an ever-increasing income for the Indonesian people. Moreover, and this is of great importance for the future development of the secondary industry, the overhead costs of European management were much higher than those of Indonesian organizations. Thus, the Indonesian was able to save money and procure new purchasing power for further industrialization.

This happy evolution is, however, pregnant with one great danger. The initiative and the necessary research for nearly all productions now in the hands of Indonesian enterprise has been carried out by European entrepreneurs. I am convinced that the disappearance of this class, so badly needed in economically not fully developed countries, would mean a catastrophic interruption of economic progress. Research could partly be taken over by government-sponsored

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* Substance of an address given at the September meeting of the Society of Netherlands Scientists in the U.S.A. at Cornell University.

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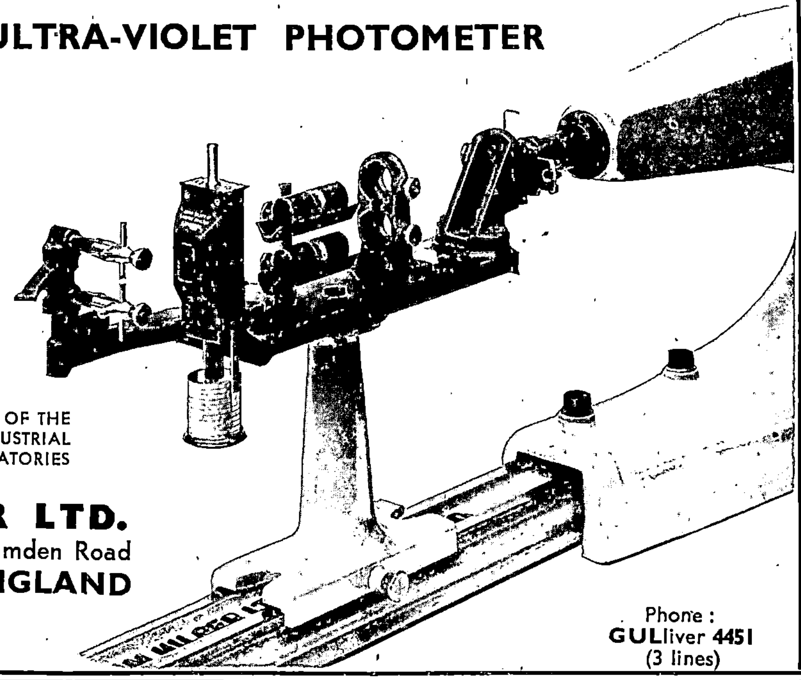

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institutions, but the divulging of realistic knowledge of national and international economic conditions is more difficult for the Government institutions; and I believe that the taking of initiative and risks lies within the scope of a government in a country like the Netherlands East Indies and should be shared by government and private capital together. It is rather the task of the Government to watch the situation closely and to plan measures through which the power to produce and to consume may be increased.

Four facts have been stressed here. First, that the formation of capital in the Netherlands East Indies formerly mainly increased prosperity abroad and not that of the native society. Secondly, that the formation of capital and the growth of buying power of the Indonesians were reached by the transition of more lucrative agricultural production to native enterprise; thirdly, that overhead expenses are much higher for Western than for Indonesian organization. Lastly, that technical knowledge, skill and experience until now have mainly been imported. This means that for future industrial development, it will be necessary that more and more technologically stabilized production of raw materials is carried out by Indonesians to promote the further formation of Indonesian capital and income; that development also should be promoted in secondary industry in order to lower cost prices and to extend consumption; that the white man's job in the future should not be one in competition on the same level of efficiency with the Indonesian producers, but to introduce new and more complicated forms of organization and technology.

In this decade of evolution in the Netherlands East Indies these new principles have been promoted as well as was possible despite the very disadvantageous rate of exchange between the Netherlands East Indies raw materials and imported consumer and capital goods. The income of the native farmer grew, thanks to his increasing share in the production of export materials. The total population increased 19 per cent during 1928–40. In the same period the total export of raw materials in guilders in 1928 decreased three per cent, but the Indonesian part of it increased sixteen per cent. This new income from agriculture was widely spread and therefore of benefit to all classes.

Thus a large demand for commodities was stimulated. In this same period, the number of mechanized factories was doubled, the number of workers in these was tripled and the output quadrupled, according to statistical data. They show the fact—so important to future evolution—that some time between 1928 and 1940 Indonesian society matured and began to build its own future.

In these years we recognize a continuous growth of small-scale industry—industry with factories of less than fifty workers and with little or no machinery, growing in output as well as in organization.

In this industry—not to be confused with home industry—nearly 1,400,000 men were working in 1930, while in 1940 this total had been increased to 2,600,000. Formerly, this type of production was merely in a stage of self-employment, mainly producing goods for consumption in the home village. In the second half of the last century, a certain degree of insular trade developed, Chinese and Javanese middlemen—the so-called *bakoel*—received most of the profit. These middlemen were as capitalistic as the Western entrepreneurs of the late nineteenth century. Similar to these, they sweated the labourer in order to fill their own pockets and to extend their production. At the same time, they were indispensable to the industry; they were bankers, suppliers of raw material and distributors, while in some instances some of the more difficult technical phases in the production were carried out under their direct supervision. Their position generally was very strong indeed. In the small-scale textile industry in middle Java, it was found in 1935 that seven key positions were still occupied by these middlemen.

In the last decade, however, this situation was rapidly changing. Small-scale workers, enlightened by vocational schooling, Press and governmental field services, are gradually organizing themselves on a co-operative basis. This is being done in several different forms according to the special needs of each type of industry, but the general characteristic is that the knowledge, ability and other services formerly embodied in the middlemen are being taken over by some kind of centralizing agency, which manages in general a mechanized finishing factory, governed by a board. The board in turn is chosen by the workers.

This agency, owned and directed by the small-scale workers themselves, supervises a fair division of profits, the reservation of a sufficient amount of money for later expansion and for vocational training of new workers. It is a kind of 'new deal' organization, which has sprung up spontaneously in the Javanese society. The Government, and more specifically the Bureau of Industry, has promoted this movement for these last seven years, under my direction, in every possible way.

Apart from this small-scale industry, there was, during this time, a continuous development of the mechanized industry. In 1940 alone, more than five hundred new factories were established. The secondary industry quickly expanded. Practically the entire field of consumers' goods, from crockery to shoes and clothing, from vegetable fats to chocolates, from soap to rubber, were influenced by this innovation. Formerly the mechanized industry had always depended on the long established agriculture and mining industries, but since 1935 an independent commodity industry began to arise.

The Government thus had to meet the demand for leaders, skilled labourers and technical instruction. First of all, consultation offices were established in the main centres. These offices had at their disposal a large staff of technical and economic instructors and also a staff of travelling vocational teachers, backed by well-equipped central research stations and laboratories. In 1940, 332 industrial schools, with Indonesian languages as their medium, and 379 with Dutch as their language, 26 technical commercial schools with Indonesian languages and 4 with Dutch, were in existence. In addition to the textile research institutions, the ceramic research works and the leather laboratory, there were also vocational schools for specialized engineers to help in large factories, or to establish themselves as leaders of smaller units. Small and very simple schools were established all over Java to educate skilled labourers for the textile, pottery, tanning and other industries. Travelling vocational teachers were also of inestimable value to the small-scale workers. Practically all these instructors, all these travelling and vocational school teachers, were Indonesians. Care also has been taken, however, to establish colleges for the education of factory leaders. In the beginning the University at Bandoeng only turned out civil engineers, but the faculty soon had to be enlarged in order to produce mechanical, technological and electrical engineers. The majority of the students were Indonesians. But a young industry is not the right place to gain general experience. Scholarships, therefore, were extended to young Indonesian graduates of the University, which would enable them to gain experience abroad. In this way, the Government hoped to create Indonesian industrialists.

Large factories also came into existence. Persons well trained for research and with wide experience are rare in the Netherlands East Indies. To meet these difficulties all these large factories are formed as affiliated enterprises of well-established factories abroad. In this way, they can profit by the research work and experience of the mother industry, and every development abroad is available with a minimum of cost.

The future of the Netherlands East Indies industry lies in the production of consumer goods, as the iron ores found in the Netherlands East Indies are poor and the coal is very soft. Because of this, heavy industry, based on iron, is practically impossible. Though we produce a large quantity of tin, this metal will continue, therefore, to remain an export product. The case is different regarding bauxite. Large masses of rich ores are available, and in the vicinity of the mines huge water-power plants can be installed. The construction of an aluminium factory had already started when the Japanese invaded Sumatra. Other metal ores found in the Netherlands East Indies, perhaps with the exception of nickel, are all poor in quality or in quantity.

On the other hand, raw materials such as rubber, sisal, wood and fibres for paper and rayon, vegetable oils, salt, tannery barks, can be had in any quantity. (Salt and sulphur as bases for chemical industries are available. Cow-hides, fish and fruits can serve as the foundation for further industry.) Water-power, coal and natural gas are readily available, and the Javanese is a good labourer, as long as he does not have to handle too much weight. As a spinner and weaver, for example, he is an excellent worker, but in the rolling mill he would lack the desired qualities.

OBITUARIES

Mr. Robert W. Paul

THE announcement of the death on March 28 of Mr. Robert W. Paul will recall to many the great part he played in the manufacture of electrical measuring instruments and the development of the cinematograph.

R. W. Paul was born at Highbury, London, in 1869 and was educated at the City of London School and at the City and Guilds Technical College, Finsbury. He worked in the electrical instrument shop of Messrs. Elliott Brothers and obtained there a practical knowledge of instrument making which was invaluable to him. In 1891 he started business for himself as an instrument maker in Hatton Garden, working long hours and using his inventive powers in perfecting the small, but important, parts of electrical instruments. He was fortunate in being able to work under the inspiration of such pioneers of electrical measurement work as Perry, Ayrton and Mather. It was on the manufacture of instruments developed with these pioneers that Paul built up a successful business.

In 1903 Paul invented a moving-coil galvanometer in which the coil is supported on a single pivot resting on a jewel, placed in the centre of a steel ball which is fixed between the poles of a permanent magnet. He gave the instrument the eminently suitable name of 'Unipivot' and it met with an immediate success. The first model gave a full deflexion for about 60 micro-amperes (coil resistance 50 ohms), a sensitivity far beyond that of any pivoted galvanometer then in existence. The 'Unipivot' maintained this proud pre-eminence for many years. Realizing the small amount of energy required to actuate it, he developed a series of resistances, shunts, etc., which made it an invaluable instrument for laboratory and test-room work. He fitted an efficient locking device which held the coil with its pivot away from the jewel, thus rendering it safe for transit. He was fond of demonstrating the robustness of the instrument and the efficiency of the clamping device by throwing it in its leather case downstairs, or even using it as a football.

In 1900 Paul transferred his works to Muswell Hill and it was there that the majority of his instruments were made.

About 1907 he commenced to make instruments designed by Albert Campbell for alternating current work, a collaboration that was most fruitful in producing instruments which have stood the test of time in a remarkable manner.

Paul's fame as an inventor will probably rest on the cinematograph rather than on his instruments. He was the first maker in Great Britain of a projector for showing pictures continuously, and his mechanism for feeding forward the film intermittently, generally referred to as the 'Maltese cross', is still universally used. The story is well known of the excitement caused in Hatton Garden when the first picture was shown in his workshop. The first semi-public display was given at the Finsbury Technical College in February 1896. He went to immense trouble to make and take pictures. In June 1896, he photographed "Persimmon" winning the Derby and projected it himself the same evening at the Alhambra. The excitement of the audience was intense, and it is said that Paul was called before the curtain six times. He fully realized the possibilities of the cinematograph for scientific work. In conjunction with Prof. Silvanus Thompson and a group of students, a series of diagrams were drawn showing changes in some phenomenon, for example, in the field between two magnets as they approached each other. These various diagrams, or pictures, were photographed separately and then projected continuously in the accepted manner of a Walt Disney film. About 1912 he disposed of his cinematograph rights and no longer interested himself in the industry.

In 1920 his business was amalgamated with the Cambridge Scientific Instrument Company, the combined firms now being known as the Cambridge Instrument Company Limited.

During recent years he developed, with Sir William Bragg, the Bragg-Paul pulsator, an apparatus for assisting breathing in cases of respiratory paralysis. He had the satisfaction of knowing that this apparatus had been instrumental in saving the lives of several children.

The scientific instrument making industry owes much to Paul's efforts to improve the technical education given to its workers. He advocated, and indeed put into practice in his own works, the holding of technical and theoretical classes for the training of apprentices in the works. He showed his further interest by founding the Paul Scholarship, which is administered by the Institution of Electrical Engineers, for enabling young students to enter the works of a scientific instrument firm for two years training.

Paul interested himself in several societies and served on the councils or boards of the Institution of Electrical Engineers, the Institute of Physics and the Physical Society. He acted as treasurer of the last-named Society during 1935–38 and as vice-president during 1939–42. He had also served the Royal Institution as a manager and a vice-president. He was awarded the sixteenth Duddell Medal by the Physical Society in 1938.

Mention should be made of the admirable collection of electrical instruments that he assembled at the Royal Albert Hall in 1931 for the Faraday Centenary Exhibition. Many of the exhibits were constructed under his direction, several with his own hands.

In his prime, Paul had immense energy and a great capacity for getting things done. With it all, he had a dry sense of humour and an attractive personality. The wreath sent by the Cinema Veterans 1903 Society for his funeral was inscribed: "The first Englishman to produce and exhibit a Cinematograph Film". R. S. WHIPPLE.

WE regret to announce the following deaths:

Dr. Edgar Allen, professor of anatomy at Yale University School of Medicine, aged fifty.

Prof. A. A. Boon, emeritus professor of chemistry at Heriot-Watt College, Edinburgh, on April 2, aged seventy-six.

Prof. Gary N. Calkins, emeritus professor of protozoology in Columbia University, on January 4, aged seventy-three.

Lieut.-Colonel E. Kitson Clark, president during 1931–32 of the Institution of Mechanical Engineers, and during 1921–22 of the Institution of Locomotive Engineers, on April 15, aged seventy-six.

Dr. Albert Hassall, bibliographer and formerly assistant chief of the Zoological Division, U.S. Bureau of Animal Industry, on September 18, aged eighty-one.

Dr. J. E. Ives, for many years physicist to the United States Public Health Service, aged seventy-seven.

Prof. A. Lloyd James, University professor of phonetics, School of Oriental and African Studies, London, aged fifty-eight.

Prof. Heinrich Zwicky, professor of veterinary medicine at the Zurich faculty of veterinary medicine.

NEWS and VIEWS

Mr. P. I. Dee, F.R.S.

MR. P. I. DEE, whose appointment to the chair of natural philosophy at the University of Glasgow was announced in NATURE of April 17, has for the past twenty years been one of the most outstanding of the younger physicists at Cambridge; first as student, then as teacher and research worker. From Marling School, Stroud, Mr. Dee entered Sidney Sussex College in 1922 as entrance exhibitioner. In 1925 he obtained a first class in Part I of the Natural Sciences Tripos and was elected scholar of his College. In the following year he gained a first in physics in Part II of the Tripos, was elected research scholar at Sidney and started work under Prof. C. T. R. Wilson at the Solar Physics Observatory. For several years after this, Mr. Dee's work continued to be mainly on the Wilson cloud chamber, and it gained him in 1928 a Taylor research fellowship (at Sidney) and in 1930 the Stokes studentship, which required his emigration to Pembroke. On the expiry of his tenure of this studentship in 1934, his own College eclaimed him with the award of a full fellowship without teaching duties). Meanwhile, the University of Cambridge had appointed him demonstrator and hen lecturer in the Cavendish Laboratory. Here, for a period, he was responsible for the teaching in the advanced practical class, and in 1937 he took over he organization of research in the High Voltage Laboratory, in which, at the outbreak of the War, he had just succeeded in bringing the second (2-million volt) Philips set into operation. When this set comes o be re-assembled and work restarted, when the War ends, his colleagues at Cambridge will miss his leadership more than brief words can convey. Mr. Dee was elected to the Royal Society's fellowship in 1941.

Prof. C. A. Elvehjem

THE thirty-second Willard Gibbs Medal, the highest award of international scope which the Chicago Section of the American Chemical Society can bestow, has been given to Prof. C. A. Elvehjem, professor of biochemistry in the University of Wisconsin. In 1928, Prof. Elvehjem with his associates received wide recognition for work involving trace elements in nutrition. They discovered that copper is essential to the formation of hæmoglobin. Later their studies revealed the place of a number of metals in nutrition, such as iron, manganese and aluminium. While at Cambridge, Prof. Elvehjem conducted studies on tissue respiration which have since been applied to the study of vitamin functions. Use of nicotinic acid in the prevention and cure of pellagra and other deficiency diseases have developed from Prof. Elvehjem's discovery. The role of nicotinic acid in animal nutrition has also been developed. He is now conducting studies on the newer members of the growing family of B vitamins.

Institute of Fuel: New President

DR. E. W. SMITH has been elected president of the Institute of Fuel for the session 1943–44, and will take office in October next. Dr. Smith has been well known in the fuel world for many years, having been chief chemist at the Birmingham Corporation Gas Department for several years before becoming technical director of the Woodall-Duckham Companies some twenty years ago. In 1941 he was appointed by Sir Andrew Duncan, then president of the Board of Trade, as director-general of gas supply in Great Britain, a position he continued to hold when the Government interests in the gas industry were transferred to the new Ministry of Fuel and Power. Having completed the work for the Government that he had undertaken to do, he resigned his position a few weeks ago.

Bicentenary of Dr. Edmund Cartwright

APRIL 24 marks the bicentenary of the birth of Rev. Edmund Cartwright, who by his invention of the power-worked loom made a notable contribution to the progress of cotton manufacture. A descendant of a family long established at Marnham, Nottinghamshire, he was educated at Wakefield Grammar School and University College, Oxford, took holy orders, and married a lady of wealth. His first appointment was to the perpetual curacy of Brampton, Yorkshire, but in 1779 he was made rector of Goadby Marwood, Leicestershire. His interests at this time were mainly connected with agriculture and poetry, but a visit to Matlock in 1784 changed the current of his life. At that time the work of Paul, Hargreaves, Arkwright and Crompton had placed the spinners far ahead of the weavers, and at Matlock, Cartwright was present at a conversation when mechanical weaving was declared an impossibility. His latent powers of invention were aroused, and at Goadby Marwood, with the assistance of the local craftsmen, he made a crude loom in which the necessary movements were all made by mechanical power.

In the following year, 1785, Cartwright secured the first of his three patents in connexion with weaving. He next opened a weaving mill at Doncaster, and there made inventions in wool combing and another for rope-making. This last, an outstanding and basic invention, was the 'Cordelier', which soon became part of everyday practice. Unfortunately, the mill was not a financial success, and by 1793 Cartwright had spent a fortune of £30,000 and had got into debt. Recording his feelings in a stoical sonnet, he left Doncaster for London and about 1800 entered the service of the Duke of Bedford at Woburn, and much of his later life was devoted to agriculture. His looms, much improved by other mechanics, gradually came into use, and in 1809 the Government was prevailed upon to award him a sum of £10,000, a part of which Cartwright used to buy a farm at Hollander, between Sevenoaks and Tonbridge. His death took place at Hastings on October 30, 1823, by which time there were probably more than twenty thousand power looms in England and Scotland. He is buried at Battle, Sussex, where a tablet to him was placed in the church.

William Wallace (1768–1843)

A CENTURY ago, on April 28, 1843, William Wallace, the Scottish mathematician and astronomer, died at the age of seventy-four. Born at Dysart, on September 23, 1768, Wallace began life as a bookbinder's apprentice, but by private study and the assistance of Robison, Playfair and others gained a sound knowledge of mathematics, and at the age of twenty-six became an assistant master in Perth Academy. Nine years later, in 1803, he became an instructor at the Royal Military College, then housed at Great Marlow. In 1819 he was chosen to succeed Leslie as professor of mathematics at the University of Edinburgh, and he held this post until seventy years of age. On retirement he was awarded a Civil List pension of £300. He had many interests, wrote much for the "Encyclopædia Britannica", contributed to the Royal Astronomical Society and other bodies, and it was largely through his efforts that the small private observatory on Calton Hill, Edinburgh, was improved, the observatory being taken over by the Crown in 1834 when Thomas Henderson became the first Astronomer Royal for Scotland.

Society of Fellows Foundation at Harvard

IT is announced in the *New York Herald Tribune* that the Society of Fellows Foundation at Harvard University, which was established by the late Dr. A. Lawrence Lowell, president of Harvard from 1909 until 1933, was also endowed by him with a fund of 2,000,000 dollars. Dr. Lowell made the gift anonymously, directing that his name was not to be divulged until after his death, when the fund was to be named after his wife, Anna Parker Lowell. By the terms of the Foundation, the principal of the fund is kept intact and the income used to enable a small number of men selected for their promise of making notable contributions to knowledge to devote their whole time to productive scholarship. The selected men are known as 'junior fellows' and receive tuition and accommodation privileges and 1,250–1,500 dollars a year. By this announcement, it is known that Harvard is indebted to Dr. Lowell not only for much of its present reputation and indirectly for its separate colleges, but also for its well-known fellowships. Dr. Lowell died on January 6, aged eighty-six (see NATURE, Feb. 13, p. 190).

Rock Paintings in Southern Rhodesia

IN a paper before the Rhodesia Scientific Association, Mr. L. Cripps has again directed attention to the rock-shelter paintings of Southern Rhodesia (*Proc. Rhodesia Sci. Assoc.*, **39**; 1942). There is still much to be done, and soon, if these paintings are to be preserved, or at least properly studied before their almost inevitable destruction follows on the more intensive opening up of the country. Incidentally, Mr. Cripps mentions the well-known site in the N'danga-Victoria district, where the so-called Egyptian figures occur. Dr. Impey, who first described the site, likened them to certain predynastic Egyptian paintings, and this equation is now assumed by a number of prehistorians. Attention might be directed, however, to some rock-shelter paintings from Ido in the Fezzan district south of Tripoli, North Africa, where very similar painted figures occur. They are reproduced (Plate lxxxi) in Leo Frobenius's recent publication "Ekade Ektob, die Felsbilder Fezzans", 1937. Perhaps for the present it would be wiser to equate the N'danga paintings with counterparts in North Africa rather than to suggest that they owe their origin to predynastic Egyptians penetrating as immigrants southwards to Rhodesia.

Seismological Tables

A SET of seismological tables by Dr. H. Jeffreys and Dr. K. E. Bullen dated 1940 and published by the British Association for the Advancement of Science from its offices at Burlington House London, W.1, has just been received. The tables are published with the assistance of a grant from the Gray Milne Trust. They have all been published previously by the Royal Astronomical Society and are reproduced in the booklet above mentioned in collected form.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Ascorbic Acid in Mashed Potatoes

Although it might be expected that the mashing of potatoes, with the intimate distribution of air throughout the heated vegetable which it involves, would cause considerable oxidation of ascorbic acid, little information on the matter seems to be available.

Experiments were therefore carried out: (1) to determine the loss incurred when potatoes were mashed and served immediately after mashing; (2) to compare the rate of destruction of ascorbic acid when mashed and whole potatoes were kept hot; (3) to compare the effect of keeping whole and mashed potatoes hot in bulk and in small helpings.

A thoroughly representative sample of about 900 gm. of medium-sized potatoes, boiled whole, was taken and one half was mashed and immediately sampled. The whole and the mashed potatoes were then weighed and, except for one small helping kept at room temperature, were kept hot in a water-heated double pan for more than two hours, at a temperature of 80–85° C., samples being removed periodically for estimation of ascorbic acid by titration against 2 : 6 dichlorphenol-indophenol. The remainder were weighed after the last sample had been taken to enable allowances to be made for the loss in weight due to evaporation during heating. This loss was too small to be significant, however.

Table 1.

Ascorbic acid in whole and mashed potatoes kept hot.

Description	Kept hot	Ascorbic acid mgm./100 gm.
Boiled	0 min.	5·4
	20 ,,	4·0
	60 ,,	2·5
	135 ,,	0·9
Boiled, then mashed	0 min.	5·0
	20 ,,	1·8
	30 ,,	0·5
	135 ,,	0·4
Whole, kept at room temperature	0 min.	5·4
	135 ,,	4·3

The results of the experiment are shown in Table 1. It is clear that mashing small quantities of potatoes has no immediate effect on their ascorbic acid content, but the rate of loss during subsequent heating is considerably accelerated.

The table also shows that while standing at room temperature cooked whole potatoes lose but a small proportion of their ascorbic acid. This supports the suggestion of Dienst[1] that it is preferable to allow vegetables to cool and to reheat them when necessary rather than to keep them hot. In another experiment, not quoted in the table, it was found that during three hours standing, even at room temperature, mashed potatoes lost more ascorbic acid than did whole potatoes.

Table 2.

Description	Ascorbic acid, mgm./100 gm.
Potatoes, whole after cooking	4·7, 4·5 (mean 4·6)
,, immediately after mashing	4·0, 4·0 (mean 4·0)

	Kept hot	Kept hot in bulk	Kept hot in individual helpings
Potatoes, whole	30 min.	4·9	—
	60 ,,	4·1	3·8
,, mashed	30 ,,	2·4	3·0
	60 ,,	0·9	1·0
Cabbage	0 min.	12·0	12·0
,,	60 ,,	5·6	4·2

Table 2 shows the effect of a similar experiment carried out with the kind co-operation of Messrs. Barkers, Ltd., under large-scale catering conditions at their canteen at Messrs. Sebro Ltd. The effect of keeping vegetables hot in bulk and in small helpings was studied simultaneously. The result confirmed the conclusions previously reached in the laboratory on the effect of mashing. The difference between vegetables kept hot in small portions and in bulk is variable; mashed potatoes lost more in bulk, while cabbage and whole potatoes incurred greater oxidation in separate helpings in this experiment. Other experiments have given variable results, but the magnitude of the differences has always been small, so that it appears not to matter whether the vegetables are served up or left in bulk during the time they are kept hot. This result agrees with that previously found by Dienst[1].

It was found that if the mashing of the potatoes took more than a short time, a loss might occur during the process. For example, when a large batch was mashed by hand the time occupied was ten minutes, and the ascorbic acid fell from 10·5 mgm. to 6·9 mgm. per 100 gm.

The significance of these results is clear. If potatoes are to be kept hot for some time before serving, as seems inevitable under many conditions of communal feeding, they should not be mashed; nor should they be mashed unless the process can be completed within two or three minutes. There seems to be little difference in ascorbic acid content between vegetables kept hot in bulk and in small helpings.

I wish to express my thanks to Dr. L. J. Harris for helpful advice and hospitality at the Dunn Nutritional Laboratory where this work was carried out.

G. N. Jenkins.

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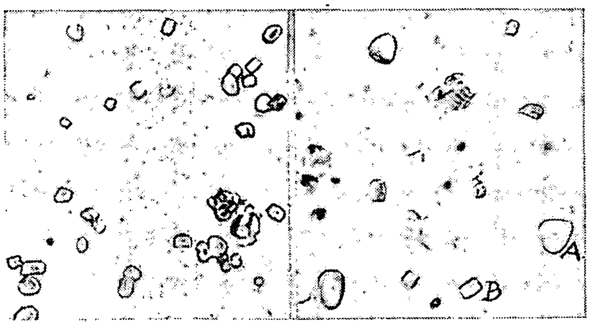
[1] Dienst, C., *Deutsch. Med. Wochenschr.* (Cologne), 68, 400 (1942).

Pure Crystalline Rennin

Northrop[1] has shown that crystallization is a useful procedure in the purification of certain enzymes. Crystalline form, however, is not reliable evidence of purity, as pointed out, for example, by Pirie[2], but may be considered as confirmatory evidence. For these reasons, in a recent attempt in this laboratory to obtain pure rennin, conditions favouring crystallization have been chosen. A preparation consisting largely of flat crystalline plates but containing a small proportion of spheroids has been obtained. From the accompanying photomicrographs it can be seen that although the outline of the plates is irregular, it tends to be triangular or rectangular, that the bounding surfaces are plane, and that the small surfaces forming the 'edges' of the plates are at right angles to the main surfaces. The latter conclusion arises from the rectangular appearance of the plates when seen 'on edge'.

A preliminary experiment has shown that the solubility of this preparation is independent of the amount of solid phase present, whether judged by the activity or by the amount of nitrogen in the solution. Thus it may be assumed, subject to confirmation by more extensive experiments, that no major impurity is present. Northrop[1] found that less than 1 per cent of mucin prevented the crystallization of pepsin, and it seems probable that a similarly small quantity of impurity is the cause of the imperfection of these rennin crystals.



1 2

1, Rennin Crystals; 2, Rennin Crystals, *A*, view of a surface, *B*, view of an 'edge'.

The following is a brief outline of the method of preparation; a fuller description will be published elsewhere. Commercial rennet, equivalent to about 80 litres of the usual cheese-making rennet, was precipitated by saturation with sodium chloride at *p*H 5·4. After solution and re-precipitation, the rennin was adsorbed on to alumina formed *in situ* from potash alum. The process of salting out and re-solution was then repeated several times. At this stage the slow addition of saturated magnesium sulphate caused the precipitation of spindle-shaped masses which could be mistaken for crystals. A closer examination, however, showed them to consist of aggregates of minute spheres held together in a transparent matrix of mucin. The removal of most of the mucin by fractional precipitation prevented the formation of these aggregates and allowed the growth of larger spheroids. Numerous repeated fractional crystallizations, by the slow addition of saturated magnesium sulphate, led eventually to the preparation shown above.

The crystals contain 13 per cent Kjeldahl nitrogen, are more soluble in cold salt solutions than in warm, and are able to clot in 10 minutes at 37° C. approximately 10^7 times their dry ash-free weight of reconstituted milk made by dissolving 12 gm. spray-dried skim milk powder in 100 ml. $N/50$ calcium chloride solution.

N. J. Berridge.

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University of Reading.

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[1] Northrop, J. H., "Crystalline Enzymes" (Columbia University Press, New York, 1939).

[2] Pirie, N. W., *Biol. Rev.*, 15, 377 (1940).

An Optically Active Arsonium Salt

Several attempts have been made in the past to synthesize an arsonium salt of type $[R^1R^2R^3R^4\text{As}]X$ (where X represents a monovalent acid radical), and then to resolve the salt into optically active forms by virtue of the asymmetric arsenic atom it contains. The synthesis of such compounds is not difficult, but the separation of the racemic salt into optically stable *dextro* and *lævo* modifications has not hitherto been achieved.

Burrows and Turner[1] prepared phenyl-α-naphthyl-benzyl-methyl arsonium bromide, converted this salt into the corresponding *d*-bromcamphor-sulphonate, and separated the latter by recrystallization into two fractions having $[M]_D = + 281^\circ$ and $+ 300^\circ$ respectively. The latter fraction was then converted into the arsonium iodide, which proved to have a fleeting rotation, and the highest value measured was $[M]_D = + 12^\circ$.

Kamai[2] prepared *p*-tolyl-benzyl-ethyl-*n*-propyl arsonium iodide, converted it into the *d*-bromcamphor-sulphonate, and separated the latter similarly into three fractions having $[M]_D = + 318^\circ$, 291°, and 285° respectively. The first fraction was converted into an (unanalysed) iodide having $[M]_D = + 45^\circ$, which rapidly racemized in solution: the other two fractions gave inactive iodides.

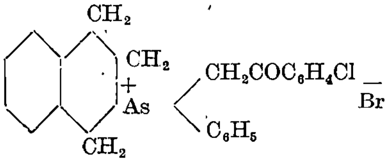
Burrows and Turner (*loc. cit.*) have obtained evidence that some quaternary arsonium salts undergo partial dissociation in solution to give a tertiary arsine and an alkyl halide, which remain in equilibrium with the undissociated salt:

$$[R^1R^2R^3R^4\text{As}]X \rightleftharpoons R^1R^2R^3\text{As} + R^4X.$$

They suggest that the rapid racemization of their *dextro*-arsonium iodide was due to the formation of such an equilibrium.

The accuracy of this suggestion, as a general explanation of the difficulty of isolating optically stable arsonium salts, could be tested by investigating either an arsonium salt having four unlike *aryl* groups attached to the arsenic atom, in which case the above dissociation would be exceedingly unlikely, or an arsonium salt which for some other reason possessed very high stability.

We have recently been investigating the synthesis and therapeutic action of various tetrahydro-*iso*-arsinolines[3]. These compounds appeared to us to afford a ready method by which Burrows and Turner's suggestion could be tested. In another investigation, the great stability of *p*-chlorophenacyl compounds compared with that of the corresponding unsubstituted phenacyl compounds had been manifest. We therefore combined 2-phenyl-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinoline with *p*-chlorophenacyl bromide to give the salt, 2-*p*-chlorophenacyl-2-phenyl-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinolinium bromide (I):

(I) 

As anticipated, the arsonium ion in this compound appeared to have great stability. The bromide was converted into the *d*-camphor sulphonate, which, however, on recrystallization showed no evidence of optical resolution. The *d*-bromcamphor sulphonate of the arsonium ion, which when isolated had $[M]_D = + 279^\circ$ in chloroform solution, was, however, readily separated by recrystallization from alcohol into a less soluble and optically pure fraction having $[M]_D = - 140^\circ$, and a more soluble (but not quite optically pure) fraction having $[M]_D = + 575^\circ$: neither fraction showed any change of rotation in chloroform solution at room temperature.

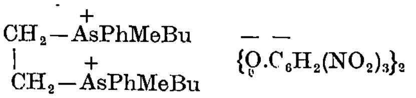
The less soluble fraction, which clearly consisted of the *l*-arsonium-*d*-bromcamphor sulphonate, was converted into the picrate, having $[M]_D = - 450^\circ$ in chloroform and $- 337^\circ$ in acetone: no racemization in either solvent could be detected. This picrate, treated with potassium iodide in ice-cold aqueous acetone, deposited the crystalline iodide, which in chloroform solution had $[M]_D = - 326^\circ$. This conversion of the picrate to the iodide was evidently accompanied by slight racemization, since recrystallization from alcohol gave the optically pure iodide, having $[M]_D = -354°$, unchanged by further recrystallization. We have yet to determine whether this slight racemization occurs during the actual conversion of the picrate to the iodide, or during the period in which the iodide remains dissolved in the acetone before crystallizing out: it is significant, however, that the iodide is optically stable both in cold chloroform and in hot alcohol.

The original racemic bromide was similarly converted into the *l*-bromcamphor sulphonate, which on recrystallization gave a less soluble fraction having $[M]_D = +140°$, which in turn furnished a picrate having $[M]_D = +457°$, both in chloroform solution.

We consider that these results afford strong confirmation of the views of Burrows and Turner. Clearly, dissociation of the above arsonium bromcamphor sulphonates and picrates is for chemical reasons almost impossible: the iodide could possibly dissociate into the original tertiary arsine and *p*-chlorophenacyl iodide, but the great stability of the arsonium ion would make such dissociation very small indeed.

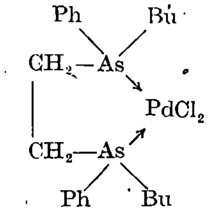
Chatt and Mann separated both ethylene-αβ-bis(phenyl-methyl-*n*-butyl-arsonium picrate[4]) (II) and the dichloro-palladium compound[5] (III) into two isomeric forms, one of which in each case must have

(II)



$$\begin{matrix}\mathrm{CH_2-\overset{+}{A}sPhMeBu}\\ |\quad + \\ \mathrm{CH_2-AsPhMeBu}\end{matrix}\quad \overset{-\ -}{\{\mathrm{O.C_6H_2(NO_2)_3}\}_2}$$

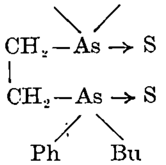
(III)



been the *meso* and one the racemic form. It is noteworthy that in neither case could either form be converted into the other even in boiling organic solvents. These results also are clearly in harmony with Burrows and Turner's suggestion. Dissociation of the picrate (II) could occur only by the formation of the ditertiary arsine and an alkyl picryl ether, which is chemically extremely unlikely: dissociation of the palladium compound (III) is prevented by the great stability of the cyclic co-ordinated system.

There is at present little evidence concerning the precise factors which determine the configurational stability of non-ionic 4-covalent arsenic compounds such as the tertiary arsine sulphides. Chatt and Mann (*loc. cit.*) separated ethylene-αβ-bis(phenyl-*n*-butyl-arsine sulphide) (IV) into two isomeric forms, one of which again must have been the *meso* and the other the racemic form. In this case, the lower melting form very readily passed over to the higher melting form, a conversion which must have involved a change of configuration of one of the arsenic atoms. On the other hand, Mills and Raper[6] showed that the *dextro* and *lævo* forms of methyl-ethyl-*p*-carboxyphenyl-arsine sulphide which they isolated possessed considerable stability, and no racemization of these compounds has been recorded.

(IV)



It is possible that in these arsine sulphides, racemization is similarly dependent on partial dissociation to tertiary arsine and sulphur, and will therefore be dependent in turn on the chemical stability of the particular compound investigated. Certainly, however, no evidence of such dissociation in solution was detected in Chatt and Mann's bis-arsine sulphide.

F. G. MANN.
F. G. HOLLIMAN.

University Chemical Laboratory,
Cambridge. March 27.

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[1] *J. Chem. Soc.*, **119**, 426 (1921).
[2] *Berichte*, **66**, 1779 (1933).
[3] NATURE, **150**, 603 (1942).
[4] *J. Chem. Soc.*, 610 (1939).
[5] *J. Chem. Soc.*, 1622 (1939).
[6] *J. Chem. Soc.*, **127**, 2479 (1925).

Town-Planning and the Small Sewage Purification Plant

IN the percolating filter system of sewage purification, at any one works a more or less constant supply of fine solids and nutritive substances in solution is fed to the filters, and from these is built up a composite growth that tends to choke the passage. The growth is counteracted by scouring organisms, usually of varied type, but including in particular enchytræid worms and the larvæ of flies. In the main, strength of sewage determines the composition of the fauna, and the season of the year determines what forms will be dominant for the time being. Reynoldson has recently shown that obstruction and ponding occur when the fauna is restricted to one dominant form[1,2]. A balanced fauna is most efficient as covering all seasons of the year, with some restriction of any one species through the effects of competition[3]. The operator at present has no control over the composition of the scouring fauna. It follows that if there are more worms there will be fewer flies, and vice versa. The fact that there must be a large output of flies makes it very undesirable that percolating filters should be close to dwellings. For though the flies are not in that dangerous class particularly attracted to human foods, it must be remembered that they originate from highly contaminated places, that they are mostly inconspicuous and that they may fall into milk and foods. No instances of ill-health, however, have yet been traced to them, except in so far as worry is a cause of illness. Proof of direct association with disease might be impossible.

During the past two years, my attention has been directed to an undesirable state of affairs in a small town which lies in the midst of a dense cluster of independent industrial townships each apparently treating its own sewage in small units. A housing estate has been allowed to approach two sides of the works in question, and the neighbouring town has similarly built up almost to the bank of a small stream that forms a third boundary. For some years there have been complaints of sewage flies entering the dwellings. The insect that causes most concern is the rather conspicuous fly, *Anisopus fenestralis*, which as the name indicates is prone to enter houses. It is not one of the commonest sewage flies, though I know of its establishment at three widely separate sewage works. Through ten years I have not taken it in the Leeds beds, though the insect is otherwise fairly common in the district. In the spot under consideration there are complaints that it has turned up in bread, and the medical officer of health showed me a fly paper that had been exposed in a small shop and was so densely covered with Anisopus (no other fly present) that it could have held few more. In another locality it is said to oviposit on such things as dish-cloths and green salads.

The information gathered was that the insect became common some eight years ago at about the time when an extensive system of sedimentation tanks was abandoned in favour of a single small patent tank. About this time, apparently, the springtail insect (*Achorutes viaticus* probably) which had been very common disappeared, and this fly made its appearance. My conclusion was that too much solid was being fed to the beds, as each piece of clinker was capped by a heap of slimy débris which was a wriggling mass of enchytræid and nematode worms, while a few inches down in the medium was an almost continuous layer of developing Psychoda and Anisopus flies. The final effluent, however, was good and settled quickly, satisfying the Rivers Board. Far removed from dwellings there would have been no real fault to find.

Chemical control of the flies was not desirable as such could not be selective, and any depletion of the fauna would have been followed by choking of the beds and ponding. It could not be certain that drastic reduction of the solids would lead to the disappearance of the established pest, and therefore an experimental approach was suggested by reducing the solids fed to one filter and subjecting another to double filtration to obtain a cleaner medium. Thus it could be found whether modification of the existing system would be justified, but it was pointed out that there must always be a lot of flies about bacteria beds and the only radical cure was substitution of an activated sludge system.

The matter is brought to light because it forms such an excellent illustration of the shortcomings of the small unit in sewage purification in congested areas. The system is most costly to set up, and once set up the local authorities are naturally reluctant to make a change. Ignorance or the cost of land often brings the works too near the town. It is not possible to provide the requisite scientific supervisor with laboratory facilities. Too often the small unit is in charge of a foreman under the supervision of an official who has many and varied duties and experience but not that very specialized knowledge required in sewage purification; engineering, chemistry, bacteriology and biology being all involved. Also since the best system is very wasteful, the research instinct is desirable so that economies can be sought[4]. In a sound system of town planning these small units should be grouped into big undertakings, as has been done with so much success at Mogden. Numerous nuisances are thus removed and economies such as the recovery of fuel gas can be effected. Especially space can be afforded so that odours, and flies when the system is by percolating filters, can be dispersed without annoyance and possible danger.

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LL. LLOYD.

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[1] Reynoldson, T. B., *J. and Proc. Inst. Sewage Purification*, 109 (1941).

[2] Reynoldson, T. B., *J. and Proc. Inst. Sewage Purification* (in the press)

[3] Lloyd, Ll. Graham, J. F., and Reynoldson, T. B., *Ann. App. Biol.*, **27**, 122 (1940).

[4] Wishart, J. M., *Surveyor*, **95**, 283 (1939).

Accuracy of Boyle's Original Observations on the Pressure and Volume of a Gas

THE following statement occurs in the Dictionary of National Biography, 2 (1908), in regard to Robert Boyle's famous law: "This approximately true principle, *although but loosely demonstrated*, was at once generalized and accepted, and was confirmed by Mariotte in 1676" [italics mine]. From this I hoped to find in Boyle's original observations a striking application of a statistical theory of erro elimination from the mathematical expression o physical laws, on which he had been working[1]. On reference to the original paper[2] this hope was not realized, for the reason that Boyle's observations were so accurate and so conclusive as to render erro elimination a work almost of supererogation. Though there are a few obvious printer's errors in the paper, the results are presented in a manner which is a model for workers in experimental science in any age.

Formal application of the theory of Boyle's first table of observations (p. 101) gave the equation

$$-\log P = 1{\cdot}00404 \log V + C,$$

where P and V are the pressure and the volume respectively, and C is a numerical constant. With only twenty-five pairs of observations it is evident that the numerical coefficient is not significantl different from unity. The words italicized in th above quotation do less than justice to the work o a great man of science.

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[1] "Inherent Relations between Random Variables", *Proc. Roy. Iris. Acad.*, **47**, A, 6, 63.

[2] "Works", 1, 100 (fol. ed. 1744).

Human Vitality and Efficiency

IN 1919 the Carnegie Institution of Washingto published a comprehensive report in which Prof. F. G Benedict and his colleagues remarked that "it i indeed surprising that after 15 years' search for nutritional level with man markedly different fro that of the normal individual, such a level shoul not have been found in all the researches conducte by this and other laboratories".

It is worthy of note that the 'laboratory of wa has now revealed such a nutritional level: fro Belgium, for example, there is news that in 1941 th normal intake of food had sunk from 2,850 calorie a day to 950. This is comparable with the dietar standard of the poor of Munich, as recorded by Rum ford at the end of the eighteenth century; and, as pointed out in 1936[1], must mean that the bas metabolism of a man is capable of being reduced t a level far below what physiologists have believe to be possible.

Data on human vitality and efficiency under pr longed restricted diet are doubtless being collected i the occupied countries.

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Hunton Bridge, Herts.
March 21.

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[1] Dufton, A. F., *Lancet*, **231**, 1535 (1936).

RESEARCH ITEMS

Inheritance of Infantile Paralysis

J. Addair and L. H. Snyder (*J. Heredity*, **33**, 307–309; 1942) have studied the geneological histories of 29 individuals showing paralytic poliomyelitis. These 29 cases are definitely genetically interrelated. The authors consider that the facts suggest the existence of an autosomal recessive gene for susceptibility. In place of finding one quarter of the children affected, only one in 5·5 has shown the disease. Unaffected children have shown no subclinical signs which could be interpreted as milder expressions of the same disease. It would therefore seem that the expression of the gene for susceptibility does not always occur; the penetrance appears to be 70 per cent.

Alcohol and Tuberculosis

In a recent paper (*Quart. J. Stud. Alcohol*, **3**, 176; 1942) Dr. Emil Bogen, director of research at the Olive View Sanatorium, California, maintains that the intake of alcoholic liquor is only indirectly affected by tuberculosis, while the pharmacological effects of alcohol are not diminished by the disease and the lethal action may be enhanced. Alcohol in sufficient concentration can kill the tubercle bacillus *in vitro*, but such concentration cannot be produced within the tissues. While the immoderate use of alcohol is associated with more advanced disease and a higher fatality-rate for tuberculosis, its moderate use may not greatly affect the incidence and course of the disease. The therapeutic administration of alcohol has no significant influence on tuberculous lesions. While admitting that the external use of alcohol may be of value in several phases of the fight against tuberculosis, Dr. Bogen concludes that the arguments for and against its internal use by a tuberculous patient are the same as those for and against its use among the general population, and the existence of the disease offers little additional support to either its supporters or opponents.

Wing Development in Aphids

A. F. Shull (*J. Exp. Zoo.*, **89**, 183–195; 1942) has shown that heat and light influence the production of winged or wingless individuals in the aphid *Macrosiphum solanifolii*. Continuous light applied to aphids, the previous offspring of which were all winged (produced in intermittent light), suppressed the wings in 50 per cent of the progeny in three days. High temperature (30°) caused the same effect in one day, while intermediate temperatures (29–26°) took a longer time to produce the same effect. It was found that if aphids have been treated for a long time with intermittent light, their reaction to continuous light was slower than those treated for a short time by intermittent light. Heat and light treatment together augment each other in effect. It is suggested that the product of some substance which inhibits wing development is influenced by both heat and light.

Effects of Leafhoppers on the Functions of Apple Foliage

In their paper entitled "The Effects of Leafhopper Feeding Injury on apparent Photosynthesis and Transpiration of Apple Leaves", G. E. Marshall, N. F. Childers and H. W. Brody point out that the object of their investigations is to study the effects of various degrees of injury of this kind (*J. Agric. Res.*, **65**, 265; 1942). They conclude that injury to apple leaves caused by several species of apple leafhoppers of the genus Typhlocyba, grape leafhoppers (Erythroneura) and the potato leafhopper (*Empoasca fabæ*) was accompanied by a more or less marked reduction in apparent photosynthesis and transpiration, especially the former. A given number of the Empoasca had a more detrimental effect on leaf metabolism than an equal number of the other leafhoppers mentioned. Cross-sections of infested leaves showed that the mesophyll-feeding types of leafhopper (that is, Erythroneura and Typhlocyba) removed the contents of the cells of the palisade parenchyma, while the spongy mesophyll cells were not significantly affected unless the leaf had been severely injured. The authors conclude that the metabolism of apple leaves may be reduced early in the growing season when the leafhopper population is moderately low. When this occurs, the capacity of the injured leaves to function in a normal way is permanently affected. It appears, therefore, that early control of these insects is an important procedure.

Heat Treatment of Potato Witches' Broom

At the annual general meeting of the American Philosophical Society during November 20–21, L. O. Kunkel read a paper on "Potato Witches' Broom Transmission by Dodder and Cure by Heat". The virus disease known as witches' broom of potato was taken to the periwinkle, *Vinca rosea*, by means of the parasite, *Cuscuta campestris*. Diseased periwinkles became stunted, assumed an upright habit of growth, and produced large numbers of secondary shoots bearing small chlorotic leaves and virescent flowers. They did not recover from the disease, but were readily cured by suitable exposures to high temperatures. The new growth produced by cured periwinkles was normal in every respect. Diseased potato plants were not cured by similar applications of heat, because they were unable to endure the treatments required to inactivate the virus; but diseased tubers endured virus-inactivating temperatures and were easily cured. When planted, they produced satisfactory yields. Recently a number of different viruses have been inactivated *in vivo* by subjecting plants to moderately high temperatures. Witches' broom is the first potato virus disease for which heat is a satisfactory curative measure.

Physiology of the Grass Seedling

The degree of the inhibition of the mesocotyl of *Avena sativa* by continuous exposure to light of low intensities in narrow bands in seven different parts of the spectrum is examined by R. L. Weintraub and E. D. McAlister (Smithsonian Misc. Coll., **101**, No. 17; 1942). The inhibitory effect is produced over a relatively great range, from 4,305 A. to 7,700 A., and in all the effective bands the inhibition is proportional to the logarithm of the light intensity. For each wave-length there appears to be a definite threshold value, suggesting that cell multiplication is inhibited at low intensities but that the inhibition of cell elongation is also involved at higher intensities. Whether expressed on an energy or a quantum basis, inhibition is greatest at about 6,600 A., with the indication of a second peak at about 6,200 A. The authors suggest that these maxima may be correlated with the absorption bands with maxima at about

625 mμ and 660 mμ observed in extracts of etiolated oat seedlings. The reaction to light of both mesocotyl and 'top' is actually and relatively greater in maize seedlings grown in a nutrient solution than in seedlings grown in distilled water (J. H. Kempton, *J. Washington Acad. Sci.*, **32**, No. 11 ; 1942). The roots do not appear to be appreciably affected by the culture solution, or by the light exposure given to the tops. The quantity of dry matter translocated is greater in the seedlings in the nutrient solution and, in conformity with this, at the end of about five days there is less residual material in their grains. Exposure to 100 foot-candle-hours of Mazda light does not affect the total amount of dry matter translocated, but even this brief period of illumination increases the dry matter in the coleoptile and enclosed leaves and reduces that in the mesocotyl, suggesting that the light initiates or speeds up the development of the leaves. The loss in dry weight of the germinating seedling is about equal to the dry weight translocated.

Freezing-Points of Solutions of Typical Colloidal Electrolytes

Conductivity alone is an untrustworthy guide in many cases as to whether or not a particular solution is that of a colloidal electrolyte. In all such cases it is essential to adduce other physical chemical evidence. As the most conclusive is the direct comparison of thermodynamic with electrical properties, S. A. Johnston and J. W. McBain have made careful freezing-point determinations for a number of colloidal electrolytes (*Proc. Roy. Soc.*, A, **181**, 119 ; 1942). It is shown that the behaviour of different groups in solution falls into several different types, although all have in common the replacement of ions by colloidal particles with increase in concentration. For example, in the family of bile salts, as in those of certain wetting agents, the conductivity almost approaches the behaviour of an ordinary electrolyte, whereas the lowering of freezing-point falls off strongly and rather abruptly. It is pointed out that the term 'critical concentration' of micelles, as often used, is either an over-simplification or a misconception. Micelles are actually formed over a fairly wide range of concentration, amounting to at least tenfold. It is found, in accordance with previous measurements of vapour pressure, that loading potassium oleate solutions with solubilized *iso*-octane scarcely affects the lowering of freezing-point, showing that it is not solubilized as independent molecules, but that it is taken up in or upon existing colloidal particles.

Nature of the Liquid State

In an article in *Current Science* (**11**, 303 ; 1942) Sir C. V. Raman summarizes some recent work on the scattering of radiation by liquids, from which it is concluded that the basic structure of a liquid is the same as that of the corresponding amorphous solid, though disturbed and enlarged by thermal agitation. The same conclusion is indicated by the study of the X-ray diffraction haloes in liquids and glass. It is the same orderliness of molecular spacing which explains the diminished light-scattering and is also responsible for the diminished intensity of diffraction, at small angles, as compared with the vapour, which is the most characteristic feature of the X-ray haloes of both liquids and amorphous solids. The article is illustrated by a number of typical light-scattering photographs.

Colour Temperature of Convective Stars

From the lists of stellar colour temperatures published by a number of observatories in the last ten years, it is known that the relative gradients or the absolute gradients scatter widely for most spectral types. The cause of this colour temperature spread has been investigated by W. S. Tai and A. D. Thackeray (*Mon. Not. Roy. Astro. Soc.*, **102**, 6 ; 1942), and they suggest that convection, in a limited number of cases, may be the factor. Their investigation indicates that, on the assumption of convection currents existing to an appreciable extent in the photospheres of stars of type *G* and later, such currents may have an important influence on the distribution of energy in the continuous spectrum. The appreciable colour effects due to convection should, it is shown, be expected primarily in a slight reddening of stars of late type. It is admitted that certain results are obtained by assumptions which, while probably true in the solar atmosphere, may not hold for stars of other types, and hence numerical results may be more or less provisional. In addition, the comparison has been restricted to that of a convective and a radiative star identical in other respects—implying an idealized problem. The influence of convection upon colour temperature, although capable of affecting stars of late type in the way suggested, is too small to contribute appreciably to the spread in the case of early type stars.

Orbital Motion and Measurements for Parallax

J. Jackson has published a paper with this title (*Mon. Not. Roy. Astro. Soc.*, **102**, 6 ; 1942), which deals with the effect of orbital motion in invalidating parallax measurements. In the case of visual binaries, where the orbital motion is known, it is a simple matter to allow for this, but in other cases —by far the more numerous—the problem is not so simple. The analysis of the measures of parallax plates requires three unknowns in the equations of condition—proper motion, parallax and a constant ; and observations made at five epochs for these three unknowns frequently show systematic residuals. Although these are not greater than might be expected from accidental error, it is just possible that the residuals arise from orbital motion. An examination of the problem leads to the interesting conclusion that in various cases the residuals can be fitted into a curve with periods of about two years, but these periods are entirely spurious. The investigations of other workers on parallax observations are considered, especially those of Holmberg and Miss Vinter Hansen, whose opinion that parallax determinations may be seriously affected by orbital motion is examined. Her list of 61 spectroscopic binaries in which $a \sin i$ exceeds 0·4 of an astronomical unit (*Pub. Astro. Soc. Pacific*, **54**, 137 ; 1942) shows that a displacement comparable with at least half the parallax may be expected. Jackson points out that 38 of these stars have periods greater than two years and that in only five of these is the error likely to exceed 0·005″, and in only two might it reach 0·01″. His conclusion is that orbital motions with a period of about one year may make parallax determinations unreliable, but if the period exceeds one and a half years the parallax will not be seriously affected. He suggests that extended series of parallax observations should be made of the nearest stars and also of stars with large values of $a \sin i$ and reasonably large parallaxes.

THEORY OF SEA WAVES

By P. J. H. UNNA

RECENT contributions in NATURE on waves[1] have been confined chiefly to cases in which the profiles are trochoidal, but they are not trochoidal when the steepness or the ratio of height of wave to depth of water is large, and adjustments are called for when the waves are near breaking point. The present purpose is to consider to what extent theory provides the clue, and what further information is required.

The following abbreviations are used :

L = length
H = height
D = depth of water
$S = H/L$ = steepness
C = stream (negative for foul)
E = energy per sq. ft. of water surface.
V = wave speed through water
G = speed of energy
q = elevation of orbits

Suffixes : s = surface
w = (speed) through water
g = ,, over ground
k = kinetic
p = potential
o = deep slack water

Units : lb., ft., sec.

To start at the beginning, L, H, D are necessary to specify a wave, and its behaviour will depend on the ratios D/L, H/L, H/D. Theory as to D/L is fairly complete, provided there is no complication due to large value of either of the other ratios ; for if the latter are small, the waves will be trochoidal for all values of D/L.

Next, it will be convenient to settle the narrowest practicable limits within which D/L cannot be regarded as either large or small. So far as the equations for wave speed are concerned, it may be taken as large provided it is at least 0·4, and as small if it is not more than 0·04, because then the limiting values, $\sqrt{gL/2\pi}$ and $\sqrt{gD}$, will not differ by more than one per cent from $\sqrt{gL/2\pi} \times \sqrt{\tanh 2\pi D/L}$. But it must be remembered that when D/L is 0·4, G/V, that is, $1-(L/V)\,(dV/dL)$, will be 6 per cent above its deep-water figure of 0·5, and that the run at the bottom will already be a sixth of the wave height.

It will also be convenient to coin some term for waves having D/L between the limits in question. 'Transitional' is suggested, as waves in gradually shoaling water have to pass through a state that is transitional between deep water and 'long'.

When S or H/D is not small, some factor, say A, has to be inserted in the expression for V. It seems that this factor is only required when S or H/D is so large that the waves are no longer trochoidal. Stokes[2] gives $A = \sqrt{1 + \pi^2 S^2}$, that is, $1 + {\cdot}5S^2$, for deep water. Rayleigh[3] confirms this, but going to closer approximation makes $A = \sqrt{1 + \pi^2S^2 + 1{\cdot}25\pi^4S^4}$. The extra term makes a little difference near breaking point.

Michell[4] says that with waves which maintain their form, which presumably means that both crest and trough move at the speed of the wave as a whole, so that the profile keeps symmetrical about the crest, S cannot exceed 0·142 in deep water, and that A is then 1·2—apparently a misprint for 1·1. This compares with 1·12 from Rayleigh's formula. Possibly it is merely intended to be a round figure, so that Rayleigh's may be taken as the more exact.

Wilton[5], professing to carry the argument to a greater degree of precision, puts $S_{\max.}$ at 0·132, with V at $2{\cdot}9\sqrt{L}$, giving $A = 1{\cdot}28$. This value for A lies so much above Rayleigh's 'A for S' curve that it is difficult to reconcile the two. The curve would have to be distorted for even moderate values of S to make it hit Wilton's point, and in the absence of any formula for the distortion it will be best to assume that Rayleigh's curve holds good throughout.

No one seems to have evolved an expression for A applicable to transitional waves. It would have to include all three ratios, as the following argument will show. A table was given in NATURE of November 14, 1942, p. 582, to show how deep-water waves change when they reach shoaling water. This table indicates that when D/L_0 = (say) 0·20, 0·10, 0·01, S/S_0 = 1·04, 1·3, 5·75, and H/H_0 = 0·92, 0·93, 1·43. It follows that H/D is at least 4, 9, 140 × S_0. As D/L_0 has to become as small as 0·01 before D/L is reduced to 0·04, this shows that even waves of almost negligible deep-water steepness must break before they become 'long', while steepish ones will acquire appreciable values of H/D soon after they become transitional. In effect, while steepness is the only disturbing factor in deep water, H/D also operates with transitional waves, and does so alone with 'long' ones.

Airy[6] (confirmed by Stokes[7] and Lamb[8]) has shown that when H/D is not small, $A = 1 + 1{\cdot}5\,\eta/D$ for 'long' waves, η being vertical height of water surface above calm-water level, and so negative at the trough. It appears from Lamb that the value of A so obtained only applies to that part of the wave at which the vertical distance in question is measured. So, as $\eta = \frac{1}{2}H + q_s$ and $-\frac{1}{2}H + q_s$ for crest and trough, and q_s for 'long' waves is $H^2/8D$, the difference in speed between crest and trough will be $(1{\cdot}5H/D)\sqrt{gD}$. The wave will take about $L/\sqrt{gD}$ sec. to cover its own length, and while it does so the crest will gain $1{\cdot}5L \times H/D$ ft. on the trough ahead, or $1{\cdot}5H/D$ per foot of travel. So, if the slope of the ground be 1 in X, the gain will be $1{\cdot}5X.H/D$ for each foot of shoaling.

The consequent steepening of the wave front will hasten breaking, and it seems reasonable to suppose that similar, though slighter, distortion takes place with transitional waves, in which case they ought to break in deeper water if the shoaling is gradual. That is precisely the opposite to what Gaillard[9] found. He made two sets of observations, one on the open coast in Florida, and the other on Lake Superior. The former included ground as steep as 1 in 12, while in the latter the slope only ranged from 1 in 90 to 1 in 30. His explanation is that the undertow, strongest where the ground is steep, causes premature breaking. That seems natural, but he seems to indicate that his conclusion also applies as between the flatter slopes on Lake Superior ; and undertow only operates within a wave-length of the shore. If it is merely a question of where breaking starts within that distance, well and good ; but if he also found that the steeper of two flattish slopes caused breaking in greater depth, the matter may call for further consideration. It is of some practical importance, as it affects the protection that an offshore shoal may be expected to afford to a breakwater, according to its ability to make the larger waves break before they reach the actual structure.

Incidentally, a splendid photograph of a wave breaking in Lake Superior at least two wave-lengths from the beach appears opposite p. 123 of Gaillard's book. So far as one can judge, the profile approximates to the theoretical one calculated by Stokes[10], in which, for deep water, the back and front should attain slopes of 30° to the horizontal, and intersect at a clean-cut crest.

Another consequence of the steepening of the wave front is the emergence of long-period waves from what seems to be an absolutely flat sea. At suitable places, well up estuaries, like Porlock or Minehead in England, it is not uncommon to see such waves appear almost spontaneously out of a glassy calm, in the form of steep and quickly growing crests, separated by long flat troughs. They only survive for a few wave-lengths before they break, and their period is in the region of 10 sec. That indicates a distant swell of the order of 500 ft., giving its last kick, and doing so in a way which can be quite spectacular.

Gaillard gives sufficient details of 122 of the breakers on Lake Superior for determining all three ratios, and the results show that breaking does almost always start before the waves become 'long' as suggested above. Thus, while D/L ranged from 0·16 to 0·04, H/L from 0·038 to 0·116, H/D from 0·38 to 0·97, the majority of the figures cluster around $D/L = 0{\cdot}10$, $H/L = 0{\cdot}055$, $H/D = 0{\cdot}6$. H ranged from 2 to 11 ft.

H/L also modifies the relation between H and E. Steepness entails some constant, say B, changing the ordinary equation into $E = 8BH^2$. Dunkerley[11] has shown that in deep water $B = 1 - \frac{1}{2}\pi^2 S^2$; while Gaillard[12] gives $1 - \frac{1}{2}\pi^2 S^2 . \coth^2 \frac{2\pi D}{L}$ for transitional waves. Dunkerley's value is the special case when D/L is large. In the other special case, when D/L is small, and the waves are 'long', Gaillard's expression reduces to $1 - \frac{1}{2}\pi^2 . H^2/8D^2$. The assumption, in each instance, is that the waves are trochoidal, in which case $E_k = E_p$. Rayleigh[13] has shown that E_k exceeds E_p when deep-water waves are so steep that his values of A operate, but the expressions he gives are scarcely in a form which admits of easy evaluation. Beyond this, there seem to be no theoretical estimates of B when either S or H/D, or both, are large.

A good example of the effects of A and B is afforded when they are taken into account in considering the consequences of a foul stream in deep water. The equation[14] connecting C and L is $C = L.V_0/L_0 - V$. Allowing for A, and taking $G_w = \frac{1}{2}V$, the limiting stream, which will cause breaking however small S_0 may have been, becomes $-\frac{1}{4}A^2V_0$, instead of $-\frac{1}{4}V_0$; though it still equals $-\frac{1}{2}V$, for V is changed from $\frac{1}{2}V_0$ to $\frac{1}{2}A^2V_0$. Thus, as Rayleigh's A is 1·100 or 1·117, according as to whether Wilton's or Michell's figure for $S_{\text{max.}}$ be accepted, the limiting stream is increased by 20 or 25 per cent. This gives more probable values than those found before, and which were described at the time as apparently on the low side. With Wilton's A as well as his $S_{\text{max.}}$, the increase would be 65 per cent. The other controlling equation, arising from the crowding up of the energy, is $H/H_0 = \sqrt{E/E_0} = \sqrt{G_0/G_g}$. This becomes $H/H_0 = \sqrt{B_0E/BE_0} = \sqrt{B_0G_0/BG_g}$.

There are thus two equations with three variables, L, H, C, so that L and H can be determined for values of C. There seems to be no doubt as to the value of A, except near breaking point, but the probability is that Dunkerley's B is too high for waves too steep to be trochoidal. Luckily, only $\sqrt{B}$ is involved, so it should not make much difference in any event. Results applicable to all values of L_0 are given below, both when Rayleigh's A is taken into account, and, for comparative purposes, also when $A = 1$. B is taken as unity in each instance. It will be seen that A increases the limiting foul stream by nearly a knot for 100-ft. waves, when $S_0 = 0{\cdot}05$ or $0{\cdot}025$. For other values of L_0 the increase would be proportional to $\sqrt{L_0}$, but the percentage loss in length at breaking point entirely depends on S_0.

Rayleigh's A; $B = 1$			$A = B = 1$		
L	S	C	L	S	C
100	0·050	0·0	100	0·050	0·0
90	0·060	—1·2	90	0·060	—1·15
80	0·075	—2·45	80	0·074	—2·1
70	0·098	—3·85	70	0·095	—3·1
			60	0·128	—3·95
61½	0·132	—5·4	59	0·132	—4·0
60	0·142	—5·8	57	0·142	—4·15
100	0·025	0·0	100	0·025	0·0
90	0·030	—1·15	90	0·030	—1·15
80	0·037	—2·25	80	0·037	—2·1
70	0·048	—3·25	70	0·048	—3·1
60	0·065	—4·25	60	0·064	—3·95
50	0·099	—5·5	50	0·092	—4·7
46	0·132	—6·45	42½	0·132	—5·15
45	0·142	—6·7	41	0·142	—5·2

To apply this table to other values of L_0, increase L proportionately to L_0, and C to $\sqrt{L_0}$.

Relevant equations, $C/\sqrt{L_0} = (L/L_0 - A\sqrt{L/L_0}) \times \sqrt{g/2\pi}$

$S/S_0 = (2L/L_0 - A\sqrt{L/L_0})^{-\frac{1}{2}} \times L_0/L$

A_0 is ignored, being almost unity.

There is one small point about this table. If $\delta V/\delta L$ and $\delta C/\delta L$ be calculated from the part based on $A = B = 1$, the results will conform with the interdependent equations $G_w = V - L.dV/DL = \frac{1}{2}V$ and $G_g = L.dC/dL$, but they will be quite discordant if calculated from the other part. That does not mean to say that A alters G_w from $\frac{1}{2}V$ when change of stream is met in deep water. A similar apparent discrepancy will be found in Rayleigh's table[15] for waves running into shoal water, for if the figures for $\delta V/\delta L$ obtained from that table be applied to the equation for G, the result will be zero for all depths, and that would be nonsense. Perhaps the explanation is that, in one case, an extra variable A, arising from change in S, and so from change in stream, is introduced, while in the other there is the extra variable D; and that the waves, at any one moment, cannot 'foretell' whether they are going to meet a different stream or depth at the next one, and so, for the time being, must behave as if A, or D, were constant. Thus modification of the value of $\delta V/\delta L$, due to future change in stream or depth, cannot affect the value of G, and make it ambiguous, before the change takes place.

Lastly, it seems that waves in mid-ocean do not attain a steepness sufficient to make it likely that A or B will materially affect their rate of growth.

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[1] NATURE, 148, 226 (1941); 149, 219 and 584 (1942); 150, 581 (1942).

[2] Stokes, "Math. and Phys. Papers", 1, 211.

[3] Rayleigh, "Scientific Papers", 6, 13. (Rayleigh's "4/5" is misprint for "5/4".)

[4] *Phil. Mag.*, (5) 36, 430 (1893).

[5] *Phil. Mag.*, (6) 23, 1055 (1913).

[6] "Encyclopedia Metropolitana", "Tides and Waves", art. 208.

[7] Stokes, "Math. and Phys. Papers", 1, 172.

[8] Lamb, "Hydromechanics", 6th ed., 262.

[9] Gaillard, "Wave Action", 120–123.

[10] Stokes, "Math. and Phys. Papers", 1, 227.

[11] Dunkerley, "Hydraulics", 2, 54.

[12] Gaillard, "Wave Action", 45–46.

[13] Rayleigh, "Scientific Papers", 6, 14.

[14] NATURE, 149, 219 (1942).

[15] Rayleigh, "Scientific Papers", 6, 8.

A MODERN STUDY OF CAULIFLORY

THE habit of flowering from buds borne upon the main branches and trunk, known as cauli-ory, is well developed in many tropical genera. uropita, Napoleona, Artocarpus and Parmentiera e well known examples. In Great Britain it is ıown well by the Judas tree (*Cercis siliquastrum* L.), ten grown in cultivation. In 1928 Prof. J. McLean hompson began an intensive study of this southern uropean example of cauliflory and also of the carob *eratonia siliqua* L.). As a result a very interesting ıper on cauliflory in the carob, intended for the *ublications of the Hartley Laboratories* in 1941, has en issued instead provisionally in typescript, with comprehensive series of photographic illustrations d diagrams.

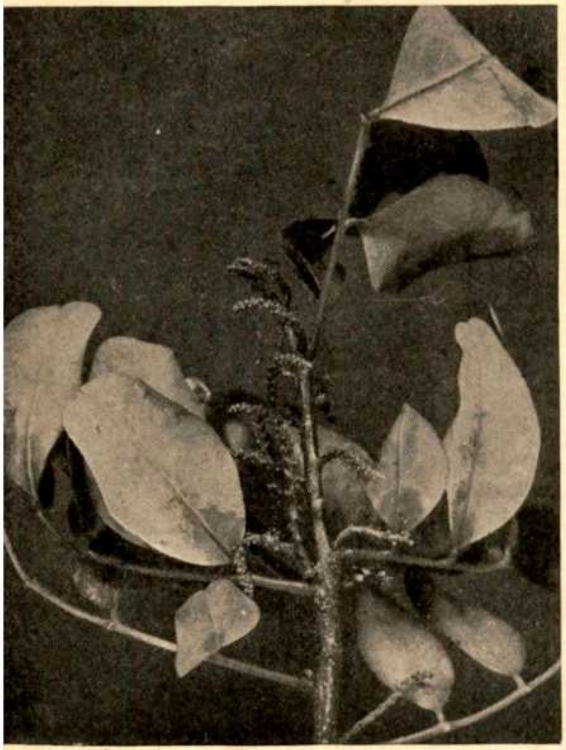

Fig. 1. EXTREMITY OF CAROB BRANCH SHOWING BASIPETAL PROGRESS OF PRIMARY LATERAL FLOWERING.

Linnæus described the carob as triœcious, but Lean Thompson's extensive collections of the plant, localities from the Maritime Alps to the Spanish ntier, make it quite clear that male, female and rmaphrodite flowers may be borne simultaneously successively on any tree. As a result growers o discard trees at an early stage as staminate, or to modify fruitfulness by grafting, are basing eir practice on very inadequate observational data.

The outstanding interest of this work is in the new ht it throws upon the habit of cauliflory.

The carob is an evergreen; each year the vegetative oot bears, apparently alternately but actually in 5 phyllotaxis, a number of large pinnate leaves. owering always commences by the terminal bud hausting itself in the production of an inflorescence. long as the terminal bud is vegetative, all lateral buds are vegetative also, but after the terminal bud has thus become reproductive, flowering from lateral buds begins and works downwards step by step. The primary lateral inflorescences thus formed, when they die back, are cut off by a layer of cork near the base of the inflorescence, leaving a short stump still bearing small dormant buds. From these buds in later seasons secondary inflorescences may arise, the stump then increasing in size. Lower on the stems these basal stumps may continue to increase in size and, by extension of the axis tissues, may be carried up the stem from their original axillary position. Thus wens of tissue are formed from which inflorescences continue to arise, secondary ones from buds lying in pits on the swelling tissue, and tertiary inflorescences from endogenous buds that form in or below the cork phellogen covering these swollen outgrowths and burst outwards through cortex and cork.

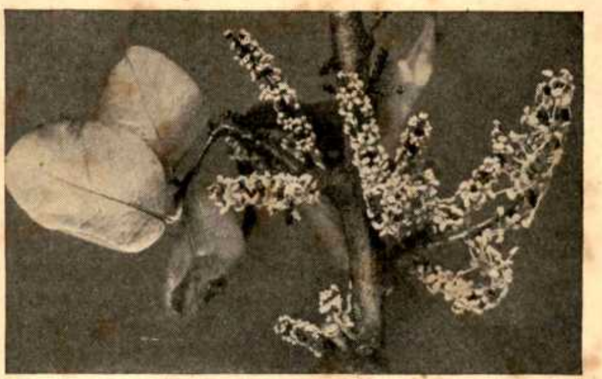

Fig. 2. PORTION OF CAROB BRANCH WITH CLUSTERS OF SECONDARY MALE INFLORESCENCES.

Thompson describes these deep-seated buds as lying in the living tree, in deep-seated pockets filled with a mucilaginous fluid which has apparently digestive action and thus frees the newly organized bud meristem from the cortical tissues in its immediate vicinity. The figures reproduced illustrate characteristic terminal, lateral primary and secondary

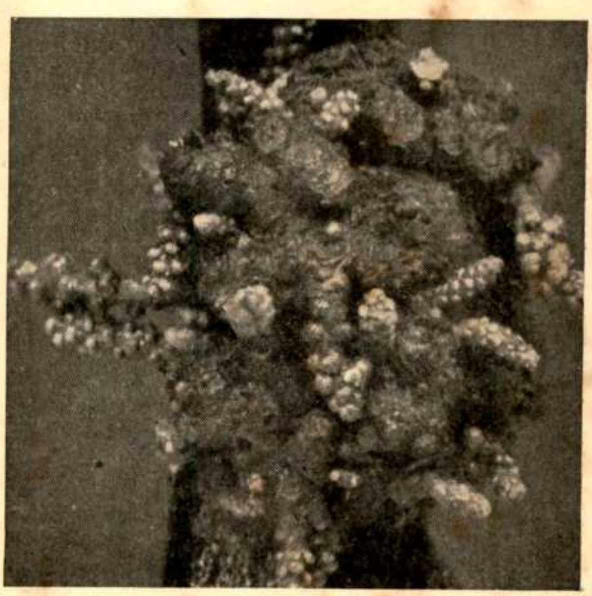

Fig. 3. PORTION OF A CAROB BRANCH WITH A LARGE WEN BEARING BOTH SECONDARY AND TERTIARY INFLORESCENCES.

inflorescences and a large wen bearing both secondary and tertiary inflorescences.

Endogenous buds on roots are, of course, well known, but endogenous buds on stems such as are associated with this cauliflorous habit seem to be a new observation.

Each leaf trace is tri-lacunar, and Thompson shows how the axis, as a result, shows fifteen broad rays in transverse section, grouped in a way determined by the phyllotaxis. Most of the endogenous buds arise opposite the rays, some evidently close to the vascular cambium, in positions where in apple or willow, for example, dormant root initials are frequently seen; other bud initials may be seen organizing in positions outside this up to the position of the phellogen.

FORTHCOMING EVENTS

Wednesday, April 28

North-East Coast Institution of Engineers and Shipbuilders (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p.m.—Mr. S. Mathwin Davis: "Naval Architectural Education".

Thursday, April 29

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Sound Films of Honorary Members and Faraday Medallists—Lord Hirst and Dr. F. B. Jewett. At 5.30 p.m.—Prof. D. R. Hartree, F.R.S.: "Mechanical Integration in the Solution of Electrical Problems" (Thirty-fourth Kelvin Lecture).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Electrical Engineering Department of the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 2 (April 29).

Instructor for training Radio Mechanics, with good qualifications in Theory and Practice of Radio Work, and a Lecturer in Mechanical Engineering, at the Rugby College of Technology and Arts—The Organizer of Further Education in Rugby, Rugby (April 30).

Head of the Department of Chemistry and Metallurgy in the Wolverhampton and Staffordshire Technical College—The Director of Education, North Street, Wolverhampton (April 30).

Lecturer in Mechanical Engineering Subjects—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (April 30).

Teacher of one or more of the following subjects: Engineering, Drawing, Workshop Practice—The Principal, County Technical College, Gainsborough, Lincs (May 1).

Headmaster of the Wimbledon Junior Technical School—The Chief Education Officer, County Hall, Kingston-on-Thames (May 3).

Assistant Lecturer to teach in the Building Department, and an Assistant Lecturer to teach in the Textile Department, of the Junior Technical School of the Burnley Municipal College—The Director of Education, Education Offices, Burnley (May 3).

Assistant Master for a Junior Course in Building at the Scarborough Technical Institute—The Secretary, Education Offices, County Hall, Northallerton (May 8).

Assistant Analyst—The City Analyst, 152 Great Charles Street, Birmingham 3 (May 8).

Assistant Lecturer in Electrical Engineering—The Bursar and Acting Registrar, University College of North Wales, Bangor (May 15).

Assistant Engineers (Civil) for the Government Railways in West Africa—The Secretary, Overseas Manpower Committee (Ref. 397), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

First Assistant to the Harbour Engineer of the Colombo Port Commission, Government of Ceylon—The Secretary, Overseas Manpower Committee (Ref. 791), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

Graduate Lecturer in Mathematics and Science, and a Lecturer in Building Subjects (including Woodwork or Plumbing) with ability to teach Elementary Mathematics—The Clerk to the Governors, Technical College, Chesterfield, Derbyshire.

Assistant Mistress to teach Biology and General Science—The Mistress in Charge, Folkestone Day Technical School for Girls, at the Technical Institute, Quaker's Yard, Glamorgan.

Visiting part-time Psychologist—The Secretary, Child's Guidance Clinic of the Lady Chichester Hospital, 33 West Street, Brighton.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

University of Leeds: The Brotherton Collection. The Sevent Report of the Committee, Session 1941–2. Pp. 6. (Leeds: Th University.) [4

The Problem of Unemployment. Pp. 40. (London: Lever Brother and Unilever, Ltd.) [4

E. A. W. Point of View on Post-War Reconstruction. Interi Report collated by Elsie E. Edwards. Pp. 54. (London: Electrica Association for Women.) 2*s*. 6*d*. [5

Are there Human Instincts? By Prof. T. H. Pear. (Reprinted fro the "Bulletin of the John Rylands Library", Vol. 27, No. 1, Decembe 1942.) Pp. 32. (Manchester: Manchester University Press.) 1*s*. 6*d* net. [10

University of Cambridge: School of Agriculture Memoirs. Memoi Nos. 13–14: A List of the Papers published by the Members of th Staff of the School of Agriculture and its Associated Research Institute during the Period Oct. 1st, 1940–Sept. 30th, 1942. Pp. 8. (Cambridge School of Agriculture.) 6*d*. [10

Hours of Work and their Influence on Health and Efficiency. B Dr. H. M. Vernon. Pp. 38. (London: British Association for Labou Legislation.) 9*d*. [11

National Smoke Abatement Society. 13th Annual Report, 1943 Pp. 16. (Epsom: National Smoke Abatement Society.) [15

War-time Information for Pharmacists. Compiled by the *Pharmaceutical Journal*. Second edition. Pp. 64. (London: Pharmaceutica Press.) 1*s*. [16

Social Insurance in the Soviet Union. By Maurice Dobb. Pp. 16 (London: National Council for British-Soviet Unity.) 2*d*. [18

Institute of Welding: Welding Research Council. Technique fo the Gas Welding of Copper. (T.6.) Pp. 28. (London: Institute o Welding.) 2*s*. 6*d*. [19

Museums and World Affairs: with Special Reference to Enginee ing and Industry. Presidential Address by Dr. F. J. North delivere before the South Wales Institute of Engineers, at Cardiff, Januar 21st, 1943. Pp. 28. (Cardiff: South Wales Institute of Engineers.) [19

Other Countries

Annual Report on the Forest Administration of Nigeria for th Year 1941. Pp. 19. (Ibadan: Forest Department.) [4

Annals of the Carnegie Museum. Vol. 29, Art. 13: A Collectio of Lepidoptera (Rhopalocera) from the Cayman Islands. By G. D Hale Carpenter and C. B. Lewis. Pp. 371–396. (Pittsburgh, Pa. Carnegie Museum.) [4

Smithsonian Institution. War Background Studies, No. 5: Th Natural-History Background of Camouflage. By Herbert Friedman (Publication 3700.) Pp. ii+17+16 plates. (Washington, D.C. Smithsonian Institution.) [8

Proceedings of the United States National Museum. Vol. 92, N 3147: New Species of Bark Beetles (Pityophthorini) from Mexic and Tropical America (Coleoptera, Scolytidæ). By M. W. Blackma Pp. 117–228+plates 20–23. Vol. 92, No. 3153: Mexican Herpet logical Miscellany. By Hobart M. Smith. Pp. 349–396. (Washingto D.C.: Government Printing Office.) [8

Ceylon. Part 4: Education, Science and Art (D). Administrati Report of the Acting Director of Agriculture for 1941. By E. Rodrig Pp. 16. (Colombo: Government Record Office.) 30 cents. [9

Smithsonian Institution. War Background Studies, No. 7: Th Japanese. By John F. Embree. (Publication 3702.) Pp. vi+42+1 plates. (Washington, D.C.: Smithsonian Institution.) [12

Report of the Secretary of the Smithsonian Institution and Financi Report of the Executive Committee of the Board of Regents for t Year ended June 30, 1942. (Publication 3696.) Pp. iii+112. (Was ington, D.C.: Government Printing Office.) 25 cents. [1

U.S. Department of Agriculture. Circular No. 643: Owlet Mot (Phalænidæ) taken in Light Traps in Kansas and Nebraska. B H. H. Walkden and D. B. Whelan. Pp. 26. 5 cents. Leaflet No. 22 The Potato Leafhopper, a Pest of Alfalfa in the Eastern States. F. W. Poos. Pp. 8. 5 cents. (Washington, D.C.: Governme Printing Office.) [1

Indian Forest Leaflet No. 28: Ash Content of some Indian F Woods. By B. S. Varma and A. C. Dey. Pp. 8. (Dehra Dun: Fore Research Institute.) 4 annas; 6*d*. [1

Smithsonian Institution. War Background Studies, No. 6: Pol nesians—Explorers of the Pacific. By J. E. Weckler, Jr. (Publicati 3701.) Pp. iv+77+20 plates. (Washington, D.C.: Smithsoni Institution.) [1

Smithsonian Miscellaneous Collections. Vol. 103, No. 7: T Musculature of the Labrum, Labium and Pharyngeal Region of Ad and Immature Coleoptera. By Carl Kester Dorsey. (Publicati 3697.) Pp. ii+42+24 plates. (Washington, D.C.: Smithsoni Institution.) [1

U.S. Office of Education: Federal Security Agency. Educati and National Defense Series, Pamphlet No. 6: What Democra Means in the Elementary School. By Helen K. Mackintosh. Pp. v+3 15 cents. Education and National Defense Series, Pamphlet No. 1 National Unity through Intercultural Education. By Rachel Dav DuBois. Pp. vi+34. 15 cents. (Washington, D.C.: Governme Printing Office.) [1

New Zealand: State Forest Service. Annual Report of the Direc of Forestry for the Year ended 31st March 1942. Pp. 20. (Wellingto Government Printer.) 9*d*. [2

U.S. Department of Agriculture. Farmers' Bulletin No. 191 Preventing Damage to Buildings by Subterranean Termites and th Control. Pp. ii+37. (Washington, D.C.: Government Print Office.) 10 cents. [2

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EDUCATION FOR CITIZENSHIP

AN AMERICAN MANIFESTO

THE appearance of an American book entitled "Education for Citizen Responsibilities"* provides the British reader with an opportunity of comparing notes on a subject which has by no means been neglected in his own country. For some years we have had an active Association for Education in Citizenship, having as its professed aims the advancement of training in the moral qualities necessary for citizens of a democracy, the encouragement of clear thinking in everyday affairs, and the acquisition of a knowledge of the modern world. The Council of the Association includes many of the most distinguished persons in British public life, and the Association has to its credit a list of publications which comprises substantial volumes on education for citizenship in primary and in secondary schools, besides a number of useful pamphlets. Not only so, but we have also a body which, established by the League of Nations Union, looks farther afield, the Council for Education in World Citizenship, a Council which, it may safely be said, is representative of all educational interests. The exalted aim of this Council is "to promote throughout the educational system such studies and teaching as may best contribute to mutual understanding, peace, co-operation and goodwill between all peoples and so lead to the building of a world commonwealth". The Council appeals, in fact, to all men and women of goodwill to act as citizens of the world, so far as in them lies.

Now it must be confessed that the English tradition in education does not take readily to such an idea as training for citizenship. Just before war broke out, the High Master of Manchester Grammar School, in the course of an article written for the Educational Yearbook of Teachers College, Columbia University, aptly summed up the attitude of the English schoolmaster. He wants to teach the truth as it may be taught to imperfect minds ; he is conscious of the welter of opinions rampant in the world ; and he is very afraid of being unfair to other people's opinions. He knows that two and two make four, and that the subject of a Latin verb is in the nominative case, whether one lives in a democratic or a totalitarian State. To lose this relative detachment would be fatal. His ambition is to train his pupils to think, to reject ready-made opinions, to know the constitution under which they live, and to know how it was brought into being. This seems to him the liberal tradition, "neither pickling an old world nor hastily swallowing a new". Even at that date, however, the writer felt bound to ask—when systems other than the democratic are confidently and sometimes aggressively proclaiming their virtues—can we with justice to our democratic ideals remain silent ?

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* Education for Citizen Responsibilities : the Roles of Anthropology, Economics, Geography, History, Philosophy, Political Science, Psychology, Sociology. By John M. Clark, Lloyd Allen Cook and Stuart A. Queen, Frank D. Graham, Richard Hartshorne, William Ernest Hocking, Roy F. Nichols and Arthur C. Bining, Frederic A. Ogg, Ernest Minor Patterson, Calvin P. Stone, Griffith Taylor, Wilson D. Wallis. Edited by Franklin L. Burdette. (Published for the National Foundation for Education in American Citizenship.) Pp. xiii+126. (Princeton, N.J. : Princeton University Press ; London : Oxford University Press, 1942.) 10*s*. net.

The last five years have provided a decisive answer to that question. The English schoolmaster of 1943 has no need to abandon his strictly judicial attitude in order to show up the totalitarian State for what it really is.

As we are reminded by more than one of the contributors to "Education for Citizen Responsibilities", the American tradition in education started from "the aristocratic and cultural plan of education" which was introduced from Europe during colonial times. Early American education, as recalled by these writers, reminds one of the Cambridge mathematician who deemed it the crowning glory of his newly discovered theorem that it could never be of the slightest use to anyone. Needless to say, they do not regret the passing from school curricula of so-called 'cultural' subjects which, in the words of one of them, "had few claims to admission other than that in the modern world they were all but useless, and must therefore be 'cultural' if anything". The reaction against the old cultural type of education was "a healthy expression of the democratic spirit, but like most reactions it fell into the trap of over-compensation". The American educational system has, in consequence, "concentrated on teaching adolescents how to make a living rather than how to live". In short, the United States, like ourselves, has yet to learn that education may be broadly vocational without ceasing to be liberal.

This is at bottom the theme of this remarkable collection of essays published for the National Foundation for Education in American Citizenship. The essays are the outcome of a conference arranged jointly by the National Foundation and the National Council for Social Studies. The contributors are a chosen band, all representing their subjects as professors in American universities. They see that Nazism to-day is "successful, dynamic, arrogant, bigoted, efficient and powerful", and that its completion can come only with the fall of free America. They ask what can American education do to meet the regimentation of totalitarian youth, and they proceed to discuss the respective "roles of anthropology, economics, geography, history, philosophy, political science, psychology, and sociology" in the enlightenment of American youth as to the high destiny of their country.

In offering comments upon these chapters we prefer to begin with philosophy, odd though the choice may at first sight seem. We certainly should not do so if the writer, Prof. Hocking of Harvard, belonged to the diminishing number who regard philosophy as "a luxury subject which is not any part of the daily bread of education". His view is the precise opposite. For him, philosophy is the daily bread of mature education, there being no subject which is so much every man's business. It is "the sum of a man's beliefs—the sum of his working beliefs, the beliefs that he is using. And as no man can live without beliefs, no man can live without a philosophy." The elementary school is the place for indoctrination, but the time comes when every boy and girl becomes a critic of the things he has received in home and church and school. This is the point at which philosophy comes in, for it is the examination of beliefs. It is guidance in the business of re-thinking. Here the sad reflection is inescapable that we in Great Britain have until now left the vast majority of our boys and girls with little or no guidance. The United States appears to be in like case. The chief of her educational failures, says Prof. Hocking, is the neglect of this moment of hunger for the means of self-judgment and for the re-examination of belief. The freer men's lives are to be, the more necessary it is that they be furnished with the technique of mature freedom, which is philosophy. Whether or not a person is led on to a study of the philosophical classics, he cannot escape from philosophy, for "every editorial, every play, every sermon, every novel—almost, we might say every conversation—conveys in some way a bit of philosophy". On this view, the late G. K. Chesterton's witty remark, that a washerwoman's philosophy is the most important thing about her, is no exaggeration. Philosophy, says Prof. Hocking, "is not begotten solely by those who call themselves philosophers". He is right in implying that all his fellow contributors make philosophical assumptions because, besides being men of science, they are men. The tendency of our leading men of science, we do not say to stray into the paths of philosophy, but to feel driven to a philosophy which may be very different from that of the Victorian professors of the subject, is obvious and conveys a lesson of wide applicability.

Scarcely less interesting than Prof. Hocking's chapter on philosophy is Prof. W. D. Wallis's on anthropology. At first sight the connexion may seem rather remote between the story of man's distant past and the education of the young American to-day, especially for a writer who holds that "a prime objective in education is fitting our citizens to be intelligent participants in a present-day world", or, perhaps more adequately, to fit them for "the world of to-morrow". The writer is cautious about that world of to-morrow, for "the impossibility of predicting in September 1939 the divagations which this war would take" strongly suggests caution. Assuming, however, that the democracies will shape the policies of peace, the United States will have "intimate contacts with peoples of varied cultures, dwellers in Oceania, Asia, and it may be Africa. . . . We shall rub shoulders and touch elbows with Europeans, Asiatics, Africans and our South American neighbours. . . . To know them as bringers and bearers of culture will add a healthy corrective to the condescension with which a people of one culture are all too prone to view those of a different culture." The value of the broad results of anthropological research in a general education could scarcely be put more cogently.

The role of geography in education for citizenship is dealt with by two writers, one of them a Canadian. Prof. Hartshorne, of Wisconsin, brings out the broad fact that modern exploration and invention have combined to tie the world into a single unit in human geography, and that we are all citizens of a world unit, even though that citizenship has no formal political organization. He adds that "whatever view one may take of American foreign policy, no intelligent citizen can be indifferent to the problems of political geography called to mind by such place names as 'Manchukuo', 'Burma Road', 'Donetz coal basin', 'Dakar', or 'Iceland' ". In the second chapter on geography, Prof. Taylor, of Toronto, gives evidence of the good fight that is being fought in order to raise the status of geography in Canadian education generally. The older geography was content to answer the question—where ? The newer geography proceeds to ask—why there ? "It is this insistence on causes which," says Prof. Taylor, "lifts our discipline from the plane of a schoolboy's task to that of one of the most interesting and valuable of the sciences." One gathers that in the United States the teacher of geography is counselled to make freer use than ever of the globe and the map of the world, and that in Canada efforts will be made to raise geography to the level of a science.

The writers of the chapter on history have no difficulty in showing how essential is that subject in an education for the responsibilities of citizenship. Education in contemporary problems without adequate historical introduction is, they truly say, like teaching only two dimensions to those living in a three-dimensional world. Only a knowledge of past errors will prevent their repetition. At the elementary stage they would have interest concentrated on the heroes of American history, their contributions to those qualities which have made the United States a great nation. At the high-school level, attention should be turned to European conditions, and then turned back again to American history in the light of the international position. At the university level, history should be less nationalistic and should become a branch of social science. Recent attempts to vitalize the teaching of history by means of discussions, problems, projects, supervised study and laboratory instruction are commended.

We turn now to the three excellent chapters on he role of economics, written by professors at Princeon, Pennsylvania and Columbia Universities. They ire all unhappy about their subject as at present aught. Even graduates, says one of them, who have 'taken" economics are as a rule illiterate in the subect, so that at present there is no supply of school eachers capable of treating it intelligently. They ave no philosophy, that is, no clear conception of nds, as distinguished from those means which are he concern of science. There is a fatal confusion etween (1) training for mere business efficiency, vhich may easily become anti-social, even to the oint of tolerating despotism and slavery, and (2) the levelopment and expression of all forms of socially egitimate power, and, as a corollary, of freedom and he truth that makes us free. There is too much of he former and too little of the latter. There is a endency to dismiss as "impractical idealism" the bligations of good citizenship in economic dealings, nd to insist that as realists all we can expect is the pirit of getting as much as possible and giving as ittle as possible. That way, says the Columbia proessor, lies the death of liberty. To all teachers n colleges and in schools the general message of hese three economists is that "there is no greater resent danger than the 'realistic' view that freedom means irresponsible self-seeking and nothing else".

The writer of the chapter on political science makes the point that the legal obligations of citizenship are at last made crystal clear by the War, and that the hour of trial and sacrifice will bring to this generation a better comprehension of the relations between citizen and government than has ever prevailed before in the United States. One of the essentials in educational effort, indeed the chief of them, is that the future citizen "be made to see unmistakably that if on one side of the shield are written *rights*, on the other are indelibly inscribed *duties*". The teaching of political science has made great headway in American universities during the last twenty years. The results in secondary schools remain to be seen. One of the results hoped for is the improvement of what are here described as barren courses in "civics".

The writers of the chapter on sociology agree with others that school curricula in the past have been too little concerned with the needs of real life, and have in fact been undemocratic in their operation. They recognize, however, that teachers do teach sociology after a fashion just as they speak prose, that is, without conscious awareness. That, they believe, is the most useful function of sociology in school education, although the point would be argued by most sociologists and by many educators. Similarly, the writer of the chapter on the role of psychology recognizes "the growing practice of introducing psychological materials without designating them by the traditional captions of academic psychology"; and if there were no other reason against systematic courses of psychology in the secondary schools, there would remain the convincing fact that well-qualified teachers of the subject are not to be had for years to come.

Though written with strict regard to the conditions of American education, this remarkable book should become known to English teachers and administrators, especially to those who regard education for citizenship as the highest aim.

AMERICAN WORK ON THE ULTRACENTRIFUGE

The Ultracentrifuge

By D. A. MacInnes, W. J. Archibald, J. W. Beams, W. B. Bridgman, Alexandre Rothen and J. W. Williams. (*Annals of the New York Academy of Sciences*, Vol. 43, Art. 5.) Pp. 173–252. (New York: New York Academy of Sciences, 1942.)

When Svedberg and Pedersen wrote their book on "The Ultracentrifuge" (Oxford: Clarendon Press, 1940), they regretted the impossibility of including all the American work as well as their own, and they hoped that the American workers would provide a supplementary monograph to fill the gap. For this reason the publication of contributions to a conference on the subject arranged by the New York Academy of Sciences is an excellent step, though it falls short of the detailed reference book which is needed.

In addition to discussing the whole field, the conference had two special aims. These were to see whether Archibald's integration of the sedimentation equation could be put to practical use, and to discuss the adoption of 0° Centigrade as the standard temperature for the measurement of physical properties of proteins. The decisions on these points are not stated; but the two unanimous decisions which were made are both praiseworthy. One was to dedicate the monograph to Svedberg, and the other was to adopt, as a convenient practical unit for sedimentation constants, the *Svedberg*, to be denoted by the letter S and equal to 10^{-13} times the absolute units, which are in seconds. In my opinion, however, there is one flaw in the details of the latter decision. The letter S has hitherto been used by Svedberg and others to denote the sedimentation constant itself, not the unit, and a change in this convention can only cause inconvenience. For example, if the contributors were loyal to their own decision, the statement of Rothen on p. 238 that "$S = 14{\cdot}2 \times 10^{-13}$" would have to read "the sedimentation constant = 14·2 S", since no symbol for the constant was suggested to replace S. Surely it is better to keep S for the constant and to use "Sved" as a distinctive abbreviation for the unit.

The first article is by Beams, thanks largely to whom ultracentrifuges are now easier to make, to install, and to run, and occupy less space, than the Svedberg ones. These desirable properties have been obtained with little or no loss in accuracy by using a vertical axis of rotation, air- or electromagnetic thrust bearings and drive, a thin flexible shaft passing through a vacuum gland, and a duralumin rotor. The first three diminish the friction so much that the power needed for steady running is small compared with that for acceleration. The vacuum gland allows the rotor chamber to be evacuated independently of the driving system. The duralumin rotor (instead of steel) requires less power to accelerate or decelerate it, which in turn allows the use of the thin shaft and of less elaborate protection against explosions. Air-drive has the advantage over oil-drive that circulation is unnecessary. The recent electrical drive is the most convenient of all, and seems to be fairly efficient. The highly accurate speed control which accompanies it seems, as Beams remarks, "at first sight a bit complicated". There is still some truth in Svedberg's early criticisms that duralumin has a slightly lower bursting speed than steel in rotors carrying cells, that the vertical axis is less convenient optically, that the flexible shaft may introduce errors through a shift in the axis of rotation, that air-drive is inefficient compared with oil-drive (though this is unimportant if little power is required), and that the whole outfit is not much cheaper than his since much of the expense is in accessories such as compressor, vacuum pump, lenses, etc., rather than in the centrifuge itself. Nevertheless, the American view that these drawbacks are outweighed by the advantages is probably correct so far as construction and installation are concerned.

The optical systems used for observing sedimentation are described in detail by Bridgman and Williams; but it may be remarked that they omit two of the chief factors limiting the accuracy of the *schlieren* method, namely, diffraction and stray light. The form of self-plotting *schlieren* method which I published, in which the diagonal stop is a single edge, not a slit, was chosen to avoid diffraction bands. The more obvious slit form, later proposed by Svensson, is in my opinion only preferable, if ever, when the solution absorbs light of the wave-length used. In that case a self-plotting absorption method is available (*Biochem. J.*, **33**, 1707; 1939).

The most original contribution to the conference comes from Archibald, who describes the integration of the sedimentation equation under the complicated conditions intermediate between those giving the sharp moving boundary used in the velocity method and the steady exponential distribution used in the equilibrium method. The successful solution of this problem is a fine achievement, and one can only regret that the conference did not carry out the suggestion of Dr. D. A. MacInnes (chairman of the conference) of discussing how these important results can best be used. A point which puzzles a non-mathematician is why a problem of this sort cannot be solved mechanically by the differential analyser. One would expect that where it is simply a question of tabulation the machine should be superior to the human brain.

A useful exposition of various points concerning the accuracy and interpretation of results is contributed by Rothen. His discussion of density and shape-factor is particularly clear. The most controversial and interesting part is his criticism of the evidence for the so-called "Svedberg unit" of protein molecular weight (which is quite unrelated to the proposed unit of sedimentation constant). Svedberg and co-workers remarked on an apparent regularity in their list of molecular weights, in that they approximated to simple multiples (mostly powers of 2) of 17,600. Rothen considers the more general question whether they approximate to any multiples at all of 17,600, and points out that with present-day accuracy this can only be tested with molecular weights below 100,000. Although the hypothesis of the "Svedberg unit" in both the above forms has often been discussed, no one seems to have devised a statistical test of its validity, possibly because both sides think that their view is too obvious to require statistics. It is desirable that such a test should be performed, since as Rothen points out elaborate speculations on protein structure have been based on the "Svedberg unit".

The work of MacInnes on electrochemical effects of centrifugal fields lends variety to the proceedings. It is nice to have this very neat example of the inevitability of thermodynamics; and the technique provides, as he says, a new way of measuring transference numbers which in some cases may be superior to the old ways. J. St. L. Philpot.

SCIENTIFIC APPROACH TO HISTORY

History and its Neighbors

By Prof. Edward Maslin Hulme. Pp. ix+197. (London, New York and Toronto: Oxford University Press, 1942.) 11*s*. 6*d*. net.

THIS is an interesting and on the whole a sound book by an emeritus professor of history of Stanford University in California. The author has read very widely and thought with an open mind about the various aspects of his subject. What he means by the 'neighbours' of history are the various subjects which contribute to or are in some way related to what he calls 'history', such as economics, law, religion, psychology and a dozen other topics which almost cover the whole field of human knowledge. That there should be so many and that he calls them 'neighbours' suggests in fact the philosophical weakness of the book—the author does not probe quite deeply enough and does not in his various suggested definitions of 'history' appreciate the vital relation between what he so describes and science or human knowledge as a whole. It is on this point that it may be useful to say a few words, without in any way disparaging Prof. Hulme's book, which would be found extremely useful by anyone studying in one of the so-called 'History Schools'.

The question which occupies a large part of Prof. Hulme's book and receives as a matter of fact a good many different answers—namely: What is history ?—is, of course, primarily a dictionary question, a matter of convention. It meant originally—as a Greek word—an inquiry. It has come to mean in the modern dictionary the written record of public events in the past. Thus 'pre-historic' happenings are those before the invention of writing, or before the use of writing for keeping records of those happenings which the men of the time thought most worthy of being kept in mind. We might, if we liked, include all happenings in the past under the title of 'history'. This would be the most philosophical view, which Prof. Hulme does not adopt. What is most important, from the educational point of view, from the point of view of the progress of humanity, is that the best and most important things in the past should be recorded, studied and kept alive in the present for the sake of the future. It has not been so hitherto, and Prof. Hulme would improve his book and his general outlook by including some of his 'neighbours' in history itself and applying to the whole that test of valuation which has just been suggested.

A written and studied record of the whole of the past is of course impossible, or rather inconceivable. The obviously right canon for choosing what part shall be recorded and studied most is that part which, so far as we can judge, has led most directly to the advancement of mankind. Clearly that has not been the canon by which recorders of history have always, or even mainly, worked in the past. Nor is it the canon by which we choose the parts of history which we present to the young as an item in their school education. It is quite another spirit which prompts the, egoistic rock inscriptions of Assyrian kings or later conquerors, or the learning by heart of all the kings of England and their most successful battles. These earliest examples of what is called in the conventional sense 'history' are, of course, commemorations of the god-king whose servant-priests alone were able to use the art of writing for his glorification. The Greeks were the irst to break this tradition and conceive of history as a social thing, describing and moralizing about the doings of their own people and others with whom hey had to do. It is for this reason that Herodotus and Thucydides have always been regarded as the fathers of history, while, coming a little later, we may ind among the Greeks, reflected in Lucretius, the dea of a general progress of mankind from savagery to civilization. Unfortunately, so far as the progress of either science or history is concerned, the brilliant Greek overture was not followed up for hundreds of years. During the nominal supremacy of the medieval Popes the records kept were mainly of their names, claims and achievements, and for many years their dependants—mostly the monks—were the only persons qualified to make written records at all. Quite naturally their temporal opponents, the sovereigns of the rising nationalist States, had at least an equal desire that their names and performances should fill the pages of recorded history. Hence we have, as the bulk of the history handed down and imparted to each successive rising generation, that list of kings and queens and their conflicts with other nations with which we are familiar and under which we have groaned.

But if we apply to it the canon of value in history which is suggested above, how little of our popular history would attain it ? In this matter, as in many others, the Renaissance is a turning point. From then onwards—let us say from Copernicus and Columbus—things begin to happen and to be recorded, which were more important to the advancement of humanity than the death or marriage of a king, but unhappily the old traditional way of recording the supposedly chief events of the past still lingered on and is by no means yet transformed. It will be a long and difficult task but, if our premises are true, mankind will steadily accomplish it and learn to look upon the past as the long and often broken ascent to a state of greater knowledge, union, power over his surroundings and happiness in the enjoyment of beauty and love. Clearly no one would forbid the study of the dark and broken passages in the past. It is in fact imperative to study and, if possible, understand them. But they are the by-ways and not the main onward track. Can we imagine man as a rational being burying himself in the story of a Nero or a Hitler and leaving aside the story of an Archimedes, a Leonardo, a Livingstone or a Darwin ? Yet we can still find approved and much used summaries of history in which the latter and similar great builders of humanity are entirely omitted. To alter this and make our popular history throw light on the future is one of the most burning, difficult but fruitful problems of the day. The world crisis in which we live has done much to make the task more apparent. F. S. Marvin.

BLOOD GROUPING AND ITS MEDICO-LEGAL SIGNIFICANCE

Medico-Legal Blood Group Determination

Theory, Technique, Practice. By Dr. David Harley. (Researches from the Inoculation Dept., St. Mary's Hospital, London, W.2.) Pp. ix+119. (London: William Heinemann (Medical Books), Ltd., 1943.) 12*s*. 6*d*. net.

This book is divided into three sections, the first of which consists of a general survey of the international (*A*, *B*, *O*) system of blood grouping and the various theories of inheritance of blood groups. This section also deals similarly with the agglutinogens, *M* and *N*, and with the occurrence of the agglutinogens *A* and *B* in saliva, semen and other secretions. The concluding chapter surveys the medico-legal applications of blood group tests.

This part of the book appears to the reviewer to suffer somewhat from over-condensation, but investigators interested in the theoretical and genetical aspects of the subject would normally refer for a more expanded treatment to Weiner's standard work on blood groups, to which the author acknowledges his indebtedness in the preface.

The second section, dealing with the actual technique employed by the author, is admirably lucid and is obviously the outcome of wide practical experience. This section is illustrated both by clear line drawings and by photographs produced by direct printing from slides used in actual tests.

The third section deals with the history and present position of blood group tests in cases of disputed paternity, and also gives details of its application in a number of criminal cases. Reference is also made to a small number of criminal cases in which semen and saliva have been grouped in connexion with criminal proceedings.

The author very rightly stresses the true significance of blood and secretion tests, since there is still a widely prevalent misconception as to this among the general public. Where the blood group of the victim agrees with that on the suspect, it does not prove that the two blood specimens came from the same original source but merely that this possibility exists. All that can be said is that they may have done. If, on the other hand, they differ, the evidence is of the utmost value from the point of view of the defence, since the stains on the clothing of the suspect could not possibly have come from the victim.

It is perhaps unfortunate that the author seems to suggest (p. 113) that "when the tests show that the stains in question could not have come from the victim the prosecution *naturally* [reviewer's italics] does not present that evidence". The function of an expert witness is to present the whole of the relevant facts for the information and guidance of the court, and it would indeed be regrettable if the public gained the impression that evidence favourable to the accused had been suppressed.

H. S. HOLDEN.

AN UNKNOWN ISLAND

Inagua

Which is the Name of a Very Lonely and Nearly Forgotten Island. By Gilbert C. Klingel. Pp. 316+28 plates. (London: Robert Hale, Ltd., 1942.) 18*s.* net.

THIS book is not great pioneering science, like the "Voyage of the Beagle" or "Wanderings in the Malay Archipelago"; it is perhaps lighter metal than Bates or Waterton or Hudson used, but it is fine stuff all the same. It reads like one of the great sea stories, with a vast deal of natural history thrown in, and it carries the reader along as Smollett or Michael Scott knew how to do. The first chapters set one longing for the sea. Two friends had set their hearts upon a ship which could be manned by two men and sailed by one, in any weather; and the little craft they got, a cutter 38 ft. long, "with stout hull, stately mast and billowing canvas", was the spit image of the one which Captain Slocum had sailed single-handed round the world some fifty years before. But unlike his, their voyage was ill-fated and short; it began with a long spell of dense fog down the coast from Chesapeake Bay, and ended in shipwreck after days of hurricane. The two explorers struggled ashore, like Robinson Crusoe, on an unknown island, from which came the pungent scent of innumerable flowers; lizards scurried ahead; a flock of flamingoes flew by; a turtle scuttled seaward from her early morning egg-laying; and a humming-bird swooped out of a cluster of prickly pear and buzzed like an angry bee. There was only one thing to do: to stay on, and explore this strange, unknown island. It turned out to be Great Inagua, a huge, scantily populated, poverty-stricken place, largest and southernmost of the Bahamas, and, in parts, a "scene of almost unbelievable beauty".

The naturalist may eke out this popular book by Mr. Klingel's other writings, for example, his papers in the *Bulletin of the American Museum of Natural History*; but there is plenty of good reading here. The dwellers in the surf, the worms, sea-anemones, sea-urchins, Grapsus-crabs, mussels with long silky byssus, have a chapter to themselves; the great caverns, which hold a teeming population of leaf-nosed bats, get another. The flamingoes are so brilliantly described that not even Mr. Abel Chapman did them better. The "utter tameness of the island birds", the gay fishes of the coral-reef, the shoals of octopuses, the multitudinous sharks (for which the author has a good word to say)—all these things and many more are described with the true naturalist's eye, and the pen of a ready and very skilful writer.

In olden times the West Indies were a happy hunting-ground for the naturalist. Hans Sloane spent a busy twelve-month in Jamaica two hundred and fifty years ago. A few great books were written by men like Catesby and Ramon de la Sagra; and Philip Gosse wrote as beautifully and intimately about Jamaica as of his native Devonshire. Many things have been done since then. Godman and Salvin have given us their great volumes, and Fawcett and Rendle have written their "Flora of Jamaica". But of the old carefree traveller's natural history there had been little or none, since Gosse wrote it just a hundred years ago, until Mr. Klingel told the story of Inagua.

D'ARCY W. THOMPSON.

MOLECULAR TINKERING AND TAILORING

Order and Chaos in the World of Atoms

A Survey of Modern Chemistry. By B. C. Saunder and R. E. D. Clark. Pp. x+266. (Bickley: Englis Universities Press, Ltd., 1942.) 8*s.* 6*d.* net.

IN a sentence, this is a sound and interestin sketch of the atomic and molecular make-up o matter, told in simple language and well illustrated with diagrams. The authors, who are attached to the University Chemical Laboratory at Cambridge, ope with a brief historical allusion to the development o ideas concerning the atom; the historical note i struck lightly at intervals throughout the composi tion, a slight dissonance being noticeable only in reference (p. 60) which might lead a lay reader to infer that Boyle knew of the existence of chlorine The historical introduction leads on to an outline o the present-day picture of atomic structures and o the various forces that enable atoms to hold together The rôle of the chemist as architect and manipulator of these infinitesimal entities is then depicted, super-brobdingnagian figure a hundred thousand miles high, with enormous hands, and moon-like eyes fifteen hundred miles across, being visualized in his tinkerings with carbon atoms an inch in width.

Notwithstanding the elusive nature of his stock-in-trade, the chemist (with the help of the physicist) has been strikingly successful in separative operations, even when dealing with the ultra-refined differences between isotopes. He has been equally fortunate in unravelling some of the fascinating secrets of the crystal, in dissecting natural molecular structures, and in weaving complex molecular patterns of his own design. Moreover, he has undertaken what the authors term the 'tailoring' of big molecules, such as those of silks and nylons, so as to bring them into arrangements to suit the needs of man. The 'untailored' molecules of plastics also come in for discussion. Finally, there are interesting chapters on the chemistry of photography and foods of the future. The development of soilless plant crops, the application of the growth hormones of plants, and the increasing use of the sea and air as sources of organic material offer fertile domains for speculations on future food supplies.

The epilogue points the moral that although the chemist has made so much progress in the synthesis and marshalling of molecules, yet "the building and the tailoring of the molecules will not of themselves ensure the continuation of civilization. The battle of the conquest of the world is a battle of the spirit of man." In other words, the man of science must be more than a molecular tinker and tailor: he cannot afford, in the interests of civilization, to neglect his wider obligations as a citizen of the world.

This is a modest book that will inform, entertain and stimulate any intelligent person of ordinary education having an interest in the contemporary position and trend of physical science. Layman and expert alike will derive pleasure from the clear and simply phrased expositions of a welter of subjects, ranging from alcohols to metastable states, from chewing-gum to the mastication of rubber, from periscopes to surface reactions, and from guncotton to the dangers of mathematics—to select only a few of the numerous 'untailored' combinations afforded by the index. In these latter days there are many who talk of bringing science to the man in the street: the authors of this book are among the doers.

JOHN READ.

HUMAN INSTINCTS

Are there Human Instincts ?

By Prof. T. H. Pear. (Reprinted from the "Bulletin of the John Rylands Library", Vol. 27, No. 1, December 1942.) Pp. 32. (Manchester: Manchester University Press, 1942.) 1*s*. 6*d*. net.

THE unfortunate habit (which is apt to persist even among those with a scientific training) of discussing verbal questions as if they were questions of fact has been responsible for much waste of time and paper in controversy over the problem of human instincts. How much of this controversy has been verbal may be seen from the fact that many of the opponents of the conception of human instincts have been willing to reintroduce essentially the same conception under some new name such as 'drive', 'urge', etc. Yet behind the mists of verbal controversy, as Prof. T. H. Pear reminds us, there is a real problem of fact—whether or not a man's behaviour is the product of a small number of inherited general dispositions such as sex, pugnacity, acquisitiveness, etc., or whether, on the contrary, the system of his motivation is acquired and the apparently deep-seated dispositions are simply reflections of the motives approved by the 'pattern' of the society in which he was born. Obviously both may be true in part, and the question of fact is then the quantitative one of how much of man's behaviour is to be explained in one way and how much in the other.

These questions of fact are perceived by Prof. Pear to remain important ones, although the current of academic fashion has set strongly against the belief in the usefulness of continuation of the discussion of human instincts which took place in the years after McDougall had popularized the conception by his "Introduction to Social Psychology". In the world of practical affairs, decisions momentous for the future are urged on us for reasons which depend not merely on the belief that there are unchangeable human instincts, but even on the idea that certain national groups have inborn characteristics which persist through the ages. To Prof. Pear, it seems that the offering to our people as a guide to international policy of "this grotesque doctrine . . . of national 'instincts' " is sufficient reason for psychologists not to regard the problem of human instincts as a dead one.

There is also the topical and very living question of whether war is caused by instinctive human aggressiveness. This is very seriously bound up with the practical problem of how we are to avoid future wars when the present War is won. That war is a result of instinctive aggressiveness is often assumed by popular writers and by psycho-analysts. It is not generally realized how dubious are the assumptions on which this opinion is based, and how much there is available even to common observation which throws doubt on whether this can be a considerable factor in the causation of war. Prof. Pear very properly points out that part of military training is directed towards developing aggressiveness in the soldier. Part of the object of war propaganda is to increase the aggressive feelings of the civilian. This is not what one would expect if the war situation were the result of the strength of inborn human aggressiveness. One may also consider that if aggressiveness towards the enemy is the approved pattern of behaviour in war-time and co-operativeness towards the enemy is suppressed, it is also true that co-operativeness within the national group is the approved pattern of behaviour in war-time and that aggressiveness within the national group is suppressed. If members of an army are not allowed to fraternize with the enemy, neither are they allowed to fight with each other. Much of the talk about war and human aggressiveness seems to lose sight of this double problem of war attitudes. War might indeed be as well regarded as the supreme example of human co-operativeness as the supreme example of human aggressiveness.

There are still many questions to be asked about human instincts before the problem can be regarded as finally settled.

R. H. THOULESS.

THE STRUCTURE OF THE UNIVERSE*

By Sir JAMES JEANS, O.M., F.R.S.

THE earliest astronomy was geocentric, the earth being supposed to be the centre of the whole universe. This view was not based on astronomical evidence, but had its roots in man's self-esteem, in his want of imagination and in the meagreness of his scientific knowledge. It met its end in the arguments of Copernicus and in the observations of Galileo.

It was succeeded by what we may call a helio-centric astronomy, in which the sun was supposed to be at or near the centre of the galactic system, and possibly also of the whole universe. This view did not result from any human frailty; there seemed to be good scientific evidence for it. For a superficial study of the sky shows that those stars that appear brightest to us, and so are presumably nearest to us, are scattered fairly uniformly in the different directions of space, while the Milky Way divides the sky into exactly equal halves, and itself looks about equally bright in all its parts. All this seemed to indicate a disk-shaped system of stars, with the sun lying in the central plane of the disk, and fairly close to its centre. Such a view of the structure of the galaxy appeared to find confirmation in the pioneer researches of the two Herschels, and in the later investigations of Kapteyn, Seares and others.

We know now that it was entirely wrong. It was wrong because these investigators had assumed that space was entirely transparent to light. We know now that the whole galactic system is permeated by a patchy fog of obscuring matter which is not dense enough to affect the light of the nearer stars appreciably, but blots out the more distant stars entirely. This fog makes the greater part of the galactic system invisible to us; if our predecessors thought they were at the centre of the galactic system, it was as a man who is in a forest in a thick fog may think he is at the centre of the forest, although in truth he is only at the centre of the small group of trees he can see through the fog.

We now know that the centre of the galaxy is far removed from the sun, and that the sun, like all the rest of the galaxy, is revolving around this distant centre. Observation shows that the sun's period of rotation is about 250 million years, and that its orbital speed is of the order of 270 km. a second. These purely observational data show that the galactic centre must be at a distance of about 36,000 light-years from the sun.

It used to be thought that our own particular galaxy was far larger than any other in the sky, but it is now clear that all galaxies are very similar in size, and also very similar in mass. Our own galactic system can be weighed by calculating the gravitational force it exerts on the sun to keep this moving in the orbit already described; the requisite mass comes out at about 150,000 million suns. It is also possible to weigh a close pair or cluster of galaxies by calculating the gravitational force they must exert on one another so as to prevent the more rapidly moving members running away into space. The average mass needed usually comes out at about that just mentioned for our own galaxy, most estimates ranging from 95,000 million to 200,000 million suns. On the evidence at present available, the galaxies seem likely to differ far less one from another than the stars of which they are composed, and we are led to picture the astronomical universe as consisting of a number of similar units—our own galaxy and the other galaxies—rather like the molecules of a gas.

On pointing a telescope in different directions in space, we see fields of stars which differ greatly from one another—a consequence of the finite size and definite structure of the galaxy. No comparable variations are to be found in the fields of galaxies seen in different directions in space. Clusters may be seen here and there, and also bare patches in places, but broadly speaking the galaxies seem to be scattered fairly evenly through space, the average distance of neighbours being something more than a million light-years. We do not know whether this uniformity of distribution persists through the whole of space or not. For the galaxies that we can see may perhaps form only a small part of some grander system, built on such a scale that no appreciable difference of structure occurs within the distances accessible to our telescopes.

If, however, the distribution is uniform throughout the whole of space, then space must be finite; otherwise it would contain an infinite amount of matter, and the gravitational force from this would be infinite, which is contrary to the fact. This alternative, then, brings us to consideration of the type of universe which Einstein contemplated in his original relativity theory. Space is curved with a positive curvature—like the surface of the earth—and is filled with matter of which the density, when averaged through a sufficiently large volume of space, is everywhere the same. On this theory the size of space is determined uniquely by this average density of matter, much as the size of an expanded balloon depends on the density, and so on the pressure, of the gas inside it. From the data already mentioned, we can deduce that the average density of matter in space must be of the order of 10^{-28} gm. per c.c., or about one atom to the cubic yard. With this density the radius of space would be about 3,300 million light-years—at least if the whole structure is at rest in a configuration of equilibrium. Thus the whole range of our biggest telescopes would be only a minute fraction of the size of space.

This seemed to provide a possible and consistent scheme until Friedmann and Lemaître showed that such a universe could not stand at rest in equilibrium. It would be unstable in the sense that space itself would have to start either expanding or contracting. Some time after this, Hubble and Humason found displacements in the spectra of distant nebulæ which, if interpreted in the simplest way as 'Doppler effects', showed that the distant nebulæ were all receding from us, and this seemed to suggest that space might actually be expanding just as Friedmann and Lemaître had predicted. Observation showed that the rate of expansion would be the same everywhere and such that, if it were maintained at its present value, the linear dimensions of space would be doubled in about 1,800 million years.

This in turn suggested that the universe might have started as an Einstein universe of the kind already described, and that the inherent instability of such a configuration had caused it to expand to its present dimensions. But the theory of relativity could not deduce the present dimensions, either from the present density of matter or otherwise, Einstein's relation between size and density referring only to a universe at rest in equilibrium.

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* Discourse delivered at the Royal Institution on March 26.

Eddington has claimed to solve the problem by quite different methods. In brief, he believes that the total number of protons in the universe must be 136×2^{256}, there being also an equal number of electrons; he has produced arguments to show that the universe cannot, from the nature of things, be anything other than this.

Knowing the number of particles in the universe, and the mass of each, it is easy to calculate the total mass of the universe, and hence the dimensions, since we already know the average density to be about 10^{-28}; the radius of curvature comes out at some 2,000 or 3,000 millions of light-years. But if the universe started as an Einstein universe in equilibrium, then the total mass it contained—the known total mass of all Eddington's particles—would fix its curvature definitely and precisely. Eddington calculates that the radius of curvature would then be 1,068 millions of light-years. Thus the expansion of the universe up to the present can only have increased its dimensions some two- or three-fold, a process which would occupy only a few thousands of millions of years. This agrees well enough with what we know as to the age of the earth, for it seems probable that the earth came into existence between 2,000 and 3,000 millions of years ago, the sun then being at the very beginning of its existence as a star. It also agrees with what we know as to the ages of the stars in general; if present conjectures as to the mechanism of stellar radiation are right, the stars can scarcely have contained available energy to provide radiation for more than a very few thousands of millions of years.

The problem has been attacked on different lines by Milne, Dirac and others. After the geocentric and the heliocentric universes had been banished from astronomy, the apparent recessions of the nebulæ seemed to suggest a galacto-centric universe, with our own galaxy as the centre from which all others were moving radially away. Milne based his theory on what he described as the 'cosmological principle' —the universe is not in any way centred in our galaxy; this occupies no specially favoured position, so that the picture which an inhabitant of our galaxy draws of the large-scale features of the universe would be equally valid for any other galaxy.

With the help of this principle, Milne draws a picture which seems at first sight to describe something totally different from the expanding universe of Friedmann and Lemaître. But Kermack and McCrea claim to have shown that the two pictures differ only in the way in which two maps of the same country differ when they are drawn on different projections. If we compare the relativity picture to a spherical projection, then Milne's picture may be compared to a Mercator projection; and McVittie has recently advanced the claim that Milne's results do not really depend on the cosmological principle at all, but can all be deduced from assumptions which Milne has unwittingly introduced under an erroneous impression that they are axiomatic. This matter is still under discussion.

Another line of investigation was opened by Dirac, possibly under the influence of a remark which Eddington had made so far back as 1923. Physics provides a natural unit of force, namely, the attraction between the nucleus and the electron in the hydrogen atom. Astronomy provides another natural unit of force—the force with which the same two particles attract one another gravitationally. This latter unit is very small in comparison with the physical unit, the two standing in the ratio of $2 \cdot 3 \times 10^{39}$ to 1. This ratio is of course a pure number, and so is independent of the particular units we use for our measurements. We have already mentioned another large number—the number of protons in the universe, which Eddington claims must be $1 \cdot 54 \times 10^{79}$. The square root of this number is $3 \cdot 9 \times 10^{39}$, and so is very close to the ratio of the electric and gravitational forces just mentioned. Eddington and Dirac have both suggested that the agreement is too good to be the result of a mere coincidence; they prefer to think that it must result from some fundamental property of the universe.

Again, physics provides a natural unit of time. It can be expressed in a variety of forms, the simplest being that it is the time light takes to travel across the diameter of an electron, about $1 \cdot 25 \times 10^{-23}$ sec. Astronomy also provides a natural unit of time; it is the fictitious time that the various galaxies would take to reach their present positions if they were all to start simultaneously from a point and travel uniformly at their present speeds of motion. This time is the same for all galaxies, being about 1,800 millions of years. Again, the ratio of these two units is a very large number; this time it is $4 \cdot 5 \times 10^{39}$, which is very near to the large numbers already mentioned. Again we must assume that the agreement is not a mere accident, but must represent something in the order of Nature.

We do not know what is the explanation of these apparent coincidences, but they seem to conceal something not yet fully explained, which when fully understood may prove to be of outstanding importance. It is true that Eddington's researches provide an explanation, but only in a rather special and very recondite form; it looks as though this explanation may be only a special case of something simpler and far wider. The fundamental constants of Nature seem to be connected by some new and hitherto unsuspected relations.

Some investigators have gone further than this, and traverse, as it seems to me, very dangerous ground. The age of the universe, expressed in terms of the natural physical unit of time, proves once again to be of the order of 10^{39}, and the suggestion is made that this also can be no mere accident, but must express something in the fixed order of Nature. The weakness in this argument is, as it seems to me, that the basic fact on which it rests can be put in the simpler form that the age of the universe is some one, two or three times the time in which space doubles its dimensions; and that when it is so expressed, it is difficult to find any 'coincidence', either real or apparent. The supposed coincidence is seen to be merely a simple transformation of one which has already been dealt with, and we must not, so to speak, try to cash in on the same coincidence twice over.

Let us, however, waive the objection and accept the suggestion made. We have then to suppose that all the numbers of the order of 10^{39}, including the age of the universe, owe their approximate equality to something in the fixed order of Nature; when the universe attains to ten times its present age, the 10^{39} which measures its age will have increased to 10^{40}, and all the other big numbers will have done likewise. Thus, the ratio of electrical to gravitational attraction will be ten times what it now is, and so on, while the number of particles in the universe will have increased a hundred-fold, so that creation must still be in progress. In brief, some or all of the quantities that we used to regard as unalterable constants of Nature lose their quality of constancy, and must change continually with the time. Milne was led to the same conclusion by a very different road; he reached it from a study of his cosmological principle. By whatever road we arrive, we come into a fantastic new world.

We may avoid the need for a continual creation of matter by supposing that the natural physical unit of time changes *pari passu* with the age of the universe. Then the measure of the age of the universe stays always the same, as does also the number of particles in the universe. But we now find that either the mass or the charge of an electron must continually change.

All this seems strange to old-fashioned physics, but it simplifies some things and removes some difficulties. When, for example, we study the spectrum of a nebula at 250 million light-years distance, we are in effect watching the emission of light from the atoms of 250 million years ago. We find that the spectral lines all show a displacement to the red, its amount being strictly proportional to the age of the light. The simplest interpretation of what we see is that the atoms of those earlier days were not the same as the atoms of to-day. Atoms seem to have given out radiation of longer wave-length than they do now, and so were apparently larger—or perhaps their electrons moved more slowly in their orbits and so took longer to complete their revolutions, possibly because the electric attraction on them was less intense. There are many possibilities, each with its merits, but also with many demerits.

Whatever the final solution of this vast problem may prove to be, it is already clear that there is no solution on the lines of the kind of dynamics that we learned at school. The mechanical interpretation of the universe fails as completely in the large-scale world of astronomy as it has already failed in the small-scale world of atomic physics. The quantum theory has replaced mechanics in the physical world; we still do not know what is destined to replace it in the world of astronomy.

CULTIVATION OF THE DOUGLAS FIR IN GREAT BRITAIN

By ALEXANDER L. HOWARD

THE question of reconstruction after the War is uppermost in many thinking minds to-day, and reafforestation should be given an important place on the programme.

Until the year 1914 a period of nearly a hundred years elapsed, during which time in Great Britain only desultory planting of little importance was carried out. The War of 1914–18 came, bringing with it a merciless but unavoidable devastation of our forests, and subsequent efforts proved wholly inadequate to restore our position. If the situation was serious then, it is desperate now, as the huge demand for timber which has arisen since the outbreak of war in 1939 has dealt another crippling blow to the woodlands of Britain. It is easy to see how this grave situation has come about. In the years 1937 and 1938 (1939 was not a complete year) we imported from the U.S.S.R., Finland, Sweden, Poland, Norway and elsewhere (including Canada and America) the following:

	Softwoods	Money value (sterling)
1937	11,732,000 loads	£51,574,000
1938	8,660,000 ,,	35,853,000

So as to make the immensity of this problem clearer to those who are less acquainted with the matter:

The quantity imported in 1937 would weigh approximately, of our class of timber	17½ million tons;
The transport of which would employ (each with an average capacity of 6 tons, but which in practice generally would average, for timber, only half the quantity named.)	3 million trucks
If the full 6 tons were carried, this would require of the average carrying capacity of timber over the railways of Britain	133,400 goods trains.

These immense shipments were suddenly and completely cut off, and we were obliged to rely on those supplies which could still be obtained from Canada, the United States, and our own home-grown forests. The largest contribution, which has consisted of Douglas fir, has so far been provided by Canada, and perhaps admittedly or unknowingly by the United States.

The Douglas fir, which flourishes in the north-west coast of North America, is remarkable for its height and size, its rapid growth, and the amazing extent of its usefulness.

According to Pliny, when Xerxes first saw the plane tree (*Platanus orientalis*) in southern Europe, he halted his entire army of 170,000 soldiers to admire the "pulchritude and procerity" of one single tree. Well might he have done so when he beheld for the first time the majestic height and wonderfully straight bole of the Douglas fir. Although, however, in places other than its natural habitat its lower branches grow in a graceful sweep, for sheer beauty it cannot be considered a competitor with the plane.

Gibson, speaking of the Douglas fir, wrote: "The largest are 300 feet high, occasionally more, and from 8 to 10 feet in diameter. The average among the Rocky Mountains is from 80 to 100 feet high and 2 to 4 feet in diameter. The amount of timber yielded by one tree may be realised from the experience of Dr. Watney (of 'Buckholt', Pangbourne), who was present at the felling of one in Washington Territory, U.S.A. The height of the trunk was 250 feet and that to the lowest bough was 157 feet. The following were the diameters at different heights above the ground:

"83 inches at 7 feet, 65 inches at 37 feet, 52 inches at 107 feet, and 32 at 191 feet.

"The trunk was sawn off at a height of 7 feet above the ground (where it showed 420 annual rings), and 184 feet of its length yielded 21,503 feet converted, equalling 1,958 feet cube. It took nine railway trucks to convey the timber from London to Pangbourne. The timber contained practically no sap, very few shakes, but some of the planks contained dead knots. Large sections of the trunks (exceeding 7 feet in diameter) are familiar in England to those who visit Kew Gardens, and the Natural History Museum, South Kensington. The Douglas fir flagstaff formerly at Kew Gardens, which was presented by the Government of British Columbia in 1861, was well known. It was 159 feet in length, and measured 1 foot 8 inches in diameter at the base, and 5 inches in diameter at the small end. This is now surpassed by the flagstaff which was erected in 1919 and, like the former one, it was presented by the Government of British Columbia."

The present flagstaff at Kew towers to a height of 214 ft., half as high again as the Nelson Monument

—measuring more than a foot in diameter at the top, and about 3 ft. in diameter at the base. If we accept reports which date back many years, a record height of more than 400 ft. has been claimed for these trees. Such a tree would top the cross on St. Paul's Cathedral by 35 ft.

It would be impossible to overrate the importance of this wood in the exceptional and unexpected demand created by the present War, the figures of production of which amaze and frighten the imagination. When we reflect upon the steady and overwhelming destruction of the timber resources of the world, and the requirements of future generations, we almost wonder how civilization can survive.

Hitherto insufficient efforts have been made to establish Douglas fir trees (*Pseudotsuga Douglasii* and *Ps. taxifolia*) in large quantities in Great Britain. The tree was introduced by William Douglas in 1827, but although occasional efforts were made to plant on a large scale, their prominence and successful production to-day is largely due to proprietors such as the owners of Lythe Hill, Surrey, Murthly Castle, Taymount, Scotland, and Powerscourt, Ireland. Although in some areas success has been achieved, it is only during the last fifty years that attempts have been made to plant this tree for ts useful qualities. While it does not thrive in some situations and on certain soils, we have evidence of the marvellous growth to which it can attain in a very short period. About seventy years ago a considerable area was planted with Douglas fir at Lythe Hill by Mr. Bicknell, then forester to the owner. On this same estate many other Douglas firs, in their rather tragic and shortened lifetime, reached a height of 100 feet and more. On the crest of the hill, and placed in such a position that it commanded a view of the whole forest, was an immense tree, known to those who frequented the site as "the monarch tree". It was also one of those planted by Mr. Bicknell about seventy years ago, an unusual specimen of white spruce (*Abies* sp., possibly *grandis*). It is not often that a man can plant a tree and during his ifetime actually see it reach a height of about 125 ft., with a straight bole moderately clear of branches to a length of 66 ft., with three leaders, bringing the ull length of the bole to about 100 ft., and yet Mr. Bicknell had this satisfaction before he died in 1941. n all its glory the tree has unfortunately been felled. t contains 544 cub. ft. of useful timber, and as growing must have weighed about twenty tons.

It is worthy of notice that the original planter must have been actuated by a diligence and enthuiasm unknown since the time of John Evelyn, as here flourishes on the estate, side by side with the Douglas firs, a great number of unusual American rees, including *Sequoia sempervirens*, *Wellingtonia igantia*, at least two sorts of maple, many Thuya, Cupressus, hemlock, juniper, *Cryptomeria japonica*, tc. The Sequoia also would seem to have found conditions favourable to its growth, since it has eached a great height and girth.

A magnificent Douglas fir can be seen at Powersourt, Co. Wicklow, Ireland, planted by the present Viscount's father between 1865 and 1870. This tree measures to-day 130 ft. in height, with a girth of 4 ft. 10 in. at breast height—equal to a diameter of nearly 5 ft. It is interesting to note that this same ree is mentioned by Henry John Elwes in "Trees f Great Britain and Ireland", when the measurement taken by him in 1904 was recorded as 100 ft. n height, 9½ ft. in girth, with a diameter of 37 in. Other examples of exceptional growth can be seen at Puck Pits in the New Forest, the magnificent avenue at Murthly Castle, and those at Taymount. When it is realized that such trees can be produced in about seventy years, the planting of Douglas firs should be widely encouraged.

A careful inquiry as to the commercial value to-day of an average tree of 70–80 years growth displays the following:

		Per tree
Scots pine		
(1)	My Report	27*s.* 0*d.*
(2)	Forestry Commission Report ..	20*s.* 0*d.*
Larch		
(1)	My Report	37*s.* 0*d.*
(2)	Forestry Commission Report ..	33*s.* 0*d.*
Average of the Douglas fir at Haslemere	more than	£6 0*s.*

Henry John Elwes, than whom there was never a more zealous planter, did not display his usual enthusiasm on the subject of Douglas fir, but it is probable that he was influenced by the result of experiments in Scotland and in the cold hills of Gloucestershire, and also because the conditions forty-two years ago were so different from those which obtain to-day.

Experiments have shown, as previously pointed out, that this particular tree can only be successfully reared in certain areas and soils, and under more scientific planting than has been practised heretofore—a handicap always unavoidable with the introduction of a tree the natural habitat of which belongs to a different country and climate.

A large quantity of cones are being collected from the Haslemere trees, which are producing good seed at a crucial moment, since the crop of Canadian seed is reported to have failed.

The vital importance of a sufficient reserve of timber supplies has been peculiarly forced upon us by a demand such as has never before been experienced in the history of Great Britain. Our woodlands, once our pride and glory, are being denuded, not only of their beauty, but also of their value, and it is therefore a national duty, incumbent upon every one of us, without delay, to pursue those measures necessary to repair the loss of such a vital necessity to the existence of the country. Among those other efforts which should be made, the planting of Douglas fir should take a prominent place.

GEOLOGY IN POST-WAR PLANNING

By PROF. P. G. H. BOSWELL, F.R.S.

FROM the reply of the Secretary of State for War to a question recently asked in the House of Commons, it seems that we have now arrived, in the fourth year of war, at the stage reached after the Gallipoli campaign of the War of 1914–18; for history is repeating itself in that water-divining in the Army is to be replaced by scientific methods of discovery (see NATURE, January 30, p. 118). A further, although belated, encouragement to geologists in their efforts to overcome public neglect of the science has just come from an American correspondent in the shape of news that the U.S. Geological Survey is actively co-operating in the preparation of maps for the North African campaign, and that geological staff officers are accompanying some of the U.S. task forces. If we do not relax our efforts it is perhaps not too much to hope that the staff of two geologists at present attached to the British Army may be increased to the total of five who were in commission in 1918—or perhaps even to the much larger number which alone would be adequate.

There are many who, like the writer, believe that the remedy for the present failure to utilize geology to the full is to be found only in broadening the basis of education, and that the cure will take a generation to be effected; but this conviction is no reason for failing to press the claim of geology as one of the primary considerations in national planning. There is still time to ensure that geologists shall take an active part in assisting with schemes of reconstruction. Their help is indispensable for the success of post-war planning, for geological knowledge is necessary whether the question is one concerned with raw materials, with the location of industries, with the allocation of land for particular purposes, or with water-supply and drainage. Certain of the large industrial organizations have wisely begun preparing for post-war conditions and demands (so far, of course, as current restrictions permit), and, in doing so, are seeking geological advice. Others will doubtless awake to the necessity for early preparation so soon as the Government announces its planning policy.

Local authorities responsible for town and country planning schemes may in some cases be unaware of geological repercussions, but if they are being advised by Prof. Patrick Abercrombie, such contacts are not likely to be ignored. At the moment, however, local authorities are also awaiting clarification of the Government's attitude towards the recommendations of the Scott and Uthwatt Committees and the Royal Commission on the Distribution of the Industrial Population (the Barlow Report). These authorities, through their planning committees, will probably have the responsibility within the framework of the Government policy, and subject to the approval of the appropriate Minister or Ministers, of determining how particular areas can best be utilized for the four respective needs of agriculture, other industries, housing and open spaces, taking into account both existing conditions and future requirements. Since geology is the science of the earth, it has a fundamental, although perhaps indirect, effect on the character and quantity of food supply by way of soil control; but it bears more directly on questions of water-supply, health and housing of the community, and the location of the industries by means of which we contrive to exist.

It is well known, of course, that the adjustment of various interests is no easy task in any scheme of planning. The responsibility for decisions will rest with the Minister of Town and Country Planning, but he will need the best advice he can command when he is faced by the problem of reconciling the conflicting claims that will inevitably arise. In many cases difficulties will be found inherent in the actual claims, apart entirely from the problems raised by particular vested interests. For example, it almost seems to be labouring the obvious to emphasize that the suitability of land for the various purposes mentioned above depends on sub-surface geological characters which cannot be altered. The characters which render land suitable for residential purposes are those desirable also for the maintenance of underground water-supplies; but houses, factories and made-up roads constitute an effective mackintosh and thus divert the rainfall. Reservation of land for agriculture and water-supply need not, it is true, lead to conflict, but scientific advice should be taken in every case. Also, the exploitation of the raw materials necessary for reconstruction must be on a huge scale; and here we should have in mind not so much the winning of coal and mineral ores, important as they are, as such common rocks as sand, gravel and stone for concrete and road metal, limestone and clay for cement, brickmaking, and chemical industries. These will require the reservation, at least for many years, of tracts of country which cannot be otherwise allocated, for example, for housing or open spaces. During the past fifty years, the tendency has been towards the abandonment of the small sand and gravel pits, village brickyards and lime-kilns worked by manual labour, and towards the concentration of these industries as large mechanized undertakings, frequently on the fringe of the conurbations. Already, in anticipation of the needs of rebuilding damaged cities and the probable expansion of their housing estates, interested parties are endeavouring to get a lien on resources of raw materials not too far distant from the markets. Further, the provision of water for public supplies and the ever-increasing needs of industry are often difficult to reconcile. Certain large works individually now require as much water as a big town or city of 100,000 to 200,000 inhabitants: if the supplies are derived from underground sources, considerable areas of the country are thus preoccupied. The development of new industries after the War of 1914–18 made heavy demands upon water-supply and in many districts upset the balance as between public and private requirements. The rayon industry with its high consumption of water is, we hope, but the forerunner of a vigorous plastics industry in Britain. Those types of plastics which will form an outlet for coal will obviously be favourably regarded, and in this connexion it is worthy of note that the raw materials, coal, limestone and water, are all abundant in Britain. But they are not all abundant in the same place, where power also must be available on a considerable scale: two of them can be economically transported, but not the third, which would involve great capital expenditure.

Much of the water required in industry is used for washing and cooling purposes, and is released again as effluent, often but little polluted, but sometimes unusable until naturally or artificially purified. The manner and ease of its disposal so as to do least harm to the community are dependent, like the location of cemeteries, sewage works and drainage generally, on the geological character of the terrain. In order to bring the partially or completely purified effluent back into service, a dual water-supply system is called for, but such a course is at present open to objection because of cost and public prejudice. No doubt many are familiar with the only too common misfortunes which have arisen from billeting, the establishment of camps, and the building of houses and works before the existence of the essential water-supply has been assured. Consultants are frequently asked to find substantial supplies of water, not only for growing communities, but also for works which were established before adequate resources were proved or where account had not been taken of the demands of expanding activity. Such lack of foresight frequently accompanies haphazard growth and is perhaps only to be expected in the absence of schemes of planning.

The effectiveness of wide-scale action during planning in the matter of allocating water-supplies is at present seriously hampered by the absence of national control. In accordance with the legal canon that there is no property in underground water, registration of wells and boreholes in Great Britain is not compulsory. Until the recommendations of the Ministry of Health Advisory Committees of 1925 and 1938 are implemented by legislation—perhaps by a system of licensing to bore (as for petroleum) and safeguarding from pollution—no protection of public or private water-supplies, either as regards quantity or quality, can be assured.

Before industrial works are located, consideration is usually given to the questions of proximity to markets, transport facilities, availability of power, and the sources of raw materials ; possibly also to the local labour market and the matter of suitable housing. To these primary considerations there should always be added those of water-supply and drainage.

The requirements of various industries for other raw materials besides water are also liable to be mutually interfering : therefore, in order fairly to reconcile the competing claims, some amount of give-and-take or rationing may become necessary in particular areas. The earlier and almost unrestricted practice of "first come, first served", defensible as it may have been before districts became congested, has led to the situation which called for the setting up of many commissions and committees of inquiry, and is now less likely to commend itself to local authorities, however influenced they may be by prospects of increased income from rates.

It is not beyond the bounds of possibility that any plans for the future will have to take account of underground accommodation and storage. However high our ideals may be for post-war international relationships, common prudence may cause politicians to make provision to meet a possible breakdown. Geological knowledge in planning is therefore indispensable if we are to be ready, albeit unwillingly, to revert to a troglodytic phase.

Many of the mistakes of the war planning, which have led to great delays, loss of labour and wear and tear of valuable machinery, might have been avoided if geological advice had been sought ; and the adverse effects could have been minimized if the co-operation between various Government departments had been more effective : that is, to use Sir Stafford Cripps's words, if there had been geological advice "at the highest level", the requirements of various war-time activities might have been more satisfactorily adjusted. The recent remark of Sir Philip Joubert at the Conference on the Planning of Science arranged by the Association of Scientific Workers should always be kept in mind : "If . . . the scientist never initiates any action and always waits to be asked a question . . . he will lose half his value". Therefore, one may feel the more encouraged in urging (especially at a time when 'science' seems in many quarters to be synonymous with physics) how important it is that a scientific advisory committee should be set up to assist the Minister of Town and Country Planning at the highest level. Such a committee, concerned with the trategy of planning, should include at least one geologist. The activities of the central planning authority will inevitably impinge on those of several Government departments. For that reason and in order to simplify the problem of co-operation, the geologist invited to serve should not be officially onnected with any Government department. His independence would be a source of strength.

SOME CZECHOSLOVAK CONTRIBUTIONS TO GENETICS (1866-1938)

By Dr. GERALD DRUCE

ALTHOUGH the breeding and crossing of plants and animals has been in vogue for a long time, the scientific control and study of the processes belong to the twentieth century ; even Mendel's early pioneer work was not appreciated for almost half a century.

Born of poor parents in 1822, Gregor J. Mendel showed promise at school and was admitted to the Augustinian monastery at Brno (Brünn) in Moravia. His scientific work began when he was sent, in 1851, to Vienna to study the natural sciences, for which he showed an aptitude. At Vienna he wrote two notes dealing with *Scopolia margaritalis* (1853) and *Bruchus pisi* (1854). Returning to Brno he taught science at the secondary school and spent eight years in a study of the crossing of peas. This work virtually ceased when he became prelate in 1868, and his after-life was clouded by a bitter controversy with the secular authorities over the taxation of the monastic domains.

Mendel knew of Darwin's theory of evolution, but did not entirely accept it. Darwin never knew of Mendel's work, which was published in the local natural history society's journal[1]. Among the very few biologists who knew of Mendel's work was the German, Nägeli, and he failed to recognize its significance. Mendel himself was depressed by the fact that his discovery was ignored. Only two minor references were made to it in his lifetime[2], and not until 1900 was its importance realized by several men of science simultaneously[3].

Mendel's experiments were carried out in a small corner of the monastery grounds where, over a period of years, he sowed his hybrid peas. He was aware of the difficulties in experimenting with hybrids, though nothing was then known of the number of possible types of offspring from any cross. No control had previously been made of separate generations nor were any reliable statistical data available, though crossing for improving stock had been practised in Bohemia, for example, at the Kladruby stud where horses had been bred since 1563. Also before Mendel's time local varieties of apples were obtained by selective crossing.

Mendel used peas because they possessed constant distinguishing characters and the hybrids were easily protected from cross-pollination. Moreover, the tedious process of artificial pollination in these plants did give good crops. A consideration of the results obtained over a number of generations are expressed in what are termed the Mendelian laws. Mendel expressed his conclusions in the following way : "In hybrids the relation of each pair of different characters (e.g., tall or dwarf, smooth or wrinkled) is independent of other differences in the original stocks" ; and "the constant characters that appear in several varieties can be obtained by repeated artificial pollination in all possible associations according to mathematical rules".

He recognized that all the characters of a plant or animal must be transmitted to the offspring through the germ cells (in plants through the pollen grains and the ovules). To this he added the conception of alternative unit characters present in the germ cells. These are inherited as units, that is, are either present or entirely absent in the offspring according to whether they are what are now termed "dominant" or "recessive". Also, recessive characters can reappear in the second generation.

In 1902, Prof. B. Němec[4] gave an account of the beginning of modern work on heredity, and by 1910 it was possible to correlate data dealing with the inheritance of acquired characters, variability and crossing in fruit trees. Even at this time the study of genetics in the Czech lands was linked closely with cytology, as is clear from the publications of Němec and Vejdovský[5], particularly the work on mitosis and polyploidy in lower plants.

After 1919, work in this field developed rapidly, both academically and in its practical applications to agriculture. The Czechoslovak Experimental Agricultural Institute near Prague and the Biological Institute were founded and, among other matters, were concerned with the improvement of crop plants and the breeding of better-quality cattle. A barley with stronger stalks and fungus-resisting wheats were obtained partly through the work of Prof. J. Peklo, and work was in progress in connexion with varieties of tobacco and with plants the seeds of which were rich in oil, the object being to improve upon the qualities of existing ones. The Association of Sugar Manufacturers had its own seed selection and improvement station at Semčice in Bohemia, and from which emanated many publications relating to the production of disease-resisting beets with high sugar content[6]. State nurseries at Průhonice and large private ones at Blatná also conducted important experiments on the crossing of flowering plants. Large quantities of seeds of new varieties were distributed annually as a result of this work. They included in 1934:

6,356	quintals	of	spring wheat	from	8	stations
5,987	,,	,,	,, barley	,,	9	,,
3,274	,,	,,	,, oats	,,	7	,,
24,688	,,	,,	sugar beet	,,	4	,,
10·5	,,	,,	poppy seed	,,	2	,,
270	,,	,,	white turnip	,,	1	,,
120	,,	,,	peas	,,	2	,,
12·9		,,	white clover	,,	1	,,
148	,,	,,	winter barley	,,	1	,,
7,506	,,	,,	,, wheat	,,	9	,,

The breeding of sheep for wool, meat and milk (used in cheese-making) was conducted with some success under Prof. F. Bílek at the Zootechnical Department of the Agricultural Experimental Institute, whilst Dr. J. Kříženecky made much progress in the scientific control of results in poultry breeding.

The genetics of man received attention in Czechoslovakia both from its physical and its mental aspects. In the former came the work of Prof. J. Matiegka, Dr. V. Suk and Dr. J. Valšík[7], whilst Prof. K. Helfort was concerned with the mental side. The Czech Eugenics Society and the Genealogical Society both base their activities on genetics, and among genealogies recently compiled from old records are those of J. A. Komenský, J. E. Purkyně (Pourkinje) and other Czechs prominent in cultural and artistic fields.

Perhaps the most outstanding work on genetics in Czechoslovakia was that due to Dr. Arthur Brožek (1882–1934), the first professor of genetics in the Charles University of Prague[8]. Brožek early applied mathematical methods to the elucidation of biological data, especially in his crosses of *Mimulus quinquevulnerus* with *M. tigrinus*. He produced, among other hybrids, a mosaic variety, *M. tigrinoides* var. *Paulina*, during experiments that involved the emasculation and artificial pollination of thousands of specimens. He took more than 20,000 photographs and made still more records of details of the results of these crossings.

His experiments with albinos revealed that the phenomenon is not inherited according to Mendelian laws. Absence of chlorophyll is localized in the plastids and not in the chromosomes. Further experiments with *M. cardinalis* produced several multicoloured varieties of pure strain. Microscopic examination revealed yellow plastids in the cells of the floral leaves in addition to the red sap which is present. In yellow varieties the sap is colourless.

Apart from these researches with Mimulus, Brožek was engaged with Bílek in experiments with caracul sheep and other animals and he wrote an exhaustive work in Czech on genetics[9]. In 1924, he visited the United States and for a time collaborated with Prof. C. B. Davenport and Prof. T. H. Morgan in their work on Drosophila.

In some ways it is possible that Brožek's work suffers from a lack of appreciation, though not to the extent that befell Mendel's. At present Czechoslovak biologists are unable to continue their work for the advancement of science, but it is clear that when the nation is again in control of its affair research in this and other subjects will be resumed

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[1] *Abhandlungen Verh. Naturforscher-Verein in Brünn*, **4**, 1 (1865). (A translation was given in *J. Roy. Hort. Soc.* in 1901.)

[2] Focke, W. D., "Pflanzenmischlinge" (1881). Peter, *Englers Bot* *Jahrbuch* (1884), refers to Mendel's work on Hieracium publishe in the Brno journal, **8**, 26 (1869).

[3] Correns, *Ber. bot. Ges.*, **17**, 158 (1900). de Vries, H., *ibid.*, **18**, 43 (1900). Tschermak, E. von, *Z. landwirt. Versuch. Oest.*, **3** (1900)

[4] Němec, B., *Ziva*, **12**, 65 (1902); **13**, 129 (1903). ("Polyploidy i Algæ" and "Cytological Observations with Higher Plants").

[5] Němec, B., "Das Problem der Befruktungsvorgänge und andere Zyto logische Fragen" (1910). Vejdovský, "Zum Problem der Verei bungsträger" (1912).

[6] Bartoš, V., *Věstník C. Jednoty Repáru*, 1–5 (1922).

[7] *Vlastivěda* (Prague, 1933). "Nauka o Plemenech" (1929).

[8] *Věstník C. bot. Spolecnosti*, **2**, 1 (1922).

[9] "Rostlinopis" (Vol. 5 of a comprehensive "Czech Handbook o Botany") (1930).

OBITUARIES

Prof. P. P. Bedson

It was a shock to learn of the death of Prof. P. P Bedson, emeritus professor of chemistry of the forme Durham College of Science, on April 4 at Hove, tw days after his ninetieth birthday and our sendin him a congratulatory letter thinking he was enjoyin reasonably good health at four score years and ten

Peter Phillips Bedson was born at Manchester o April 2, 1853, the third son of George Bedson, hi second Christian name being taken from his mothe He was educated at Manchester Grammar School an graduated at Owens College under Roscoe, continue his studies in London (Dalton Scholar 1875), and i 1876 proceeded to Bonn to work for two years with Kekulé. On his return he spent the years 1878–8 on Roscoe's staff and then at the age of twenty-nin was elected to the chair of chemistry in the Colleg of Science, Newcastle-upon-Tyne, which he occupie for thirty-nine years. He thus saw the rise of th College from the small beginnings to near its presen stature. His first published work was from Manchester (1876) on the double compounds of ethe with titanium chloride and vanadium oxychlorid At Bonn he worked on substituted phenylaceti acids, an integral part of the indigo problem (1877).

On coming to Newcastle, Bedson showed courage in linking his chemical fortunes with those of the district by attacking the chemistry of coal. His pioneering work included the demonstration of the presence of paraffins up to pentane, the investigation of the wet oxidation of coal and the solvent action of pyridine. These methods have in later days proved of the utmost importance in the hands of Bone and Fischer. Other important aspects of his work were connected with the explosive nature of coal dust in air and the composition of colliery waters. He also demonstrated the presence of argon in rock salt, and as a regular lecture experiment he showed the rhythmic precipitation of copper ferrocyanide in gelatine many years before its rediscovery by Liesegang. With Charleton-Williams he translated Lothar Meyer's "Modern Theories of Chemistry" and in 1896 gave the Lothar Meyer Memorial Lecture in London.

Up to the end of last century, scarcely any student entering the College had any prior knowledge of chemistry, and as the numbers were growing rapidly, the staffing of his department invariably lagged behind the number of students to be instructed. Members of staff taught for thirty-five hours a week, including some evenings, and were fortunate to get Wednesday afternoon free for research! By contrasting these conditions with those obtaining in universities to-day, Bedson's original work constitutes a remarkable achievement. In addition to the above handicap, he became necessarily more involved in the administration of the rapidly growing institution, of which he became vice-principal; he was also later a justice of the peace.

Although of small stature, Bedson was of striking personality and a very successful teacher. His lectures, on the preparation of which he spared neither time nor trouble, were clear, logical and well illustrated by experiments. Cheerful and ever humorous, he was yet a strict disciplinarian of the old school, but was nevertheless loved and respected by his students, to whom he was affectionately known as 'Peter'. It is, however, alleged that on one occasion an errant student on being questioned by his professor replied that he was seeking salt-petre! His chief recreation was music. He was a competent violinist and an ardent concert-goer.

He is survived by his lifelong helpmeet, Mrs. Bedson, and one son and one daughter, the former an eminent bacteriologist.

A few years after his retirement his successors founded "The Bedson Club" in honour of the man who had done so much to establish the School of Chemistry in the University of Durham. So his name goes on, though we mourn the loss of an able chemist and a father to King's College.

In the preparation of this note I have had the invaluable help of Dr. J. A. Smythe, for long a member of Prof. Bedson's staff. G. R. CLEMO.

The Rev. E. N. Neumann, S.J.

THE REV. EMMANUEL NAVARRO NEUMANN, *S.J.*, died on January 30, 1941, according to the Memorabilia Societatis Jesu of December 1941 (delayed on account of the War). The greater part of his research studies and labours was spent in the field of geodynamics. He operated observatories, issued bulletins, developed seismographs and published more than three hundred separate articles on seismology. With other Jesuit men of science he was exiled from Spain by the anti-clerical Government in 1931, and resided in Italy for some time. On August 11, 1938, the Cartuja (Granada) Observatory was restored to the Jesuits and Father Navarro Neumann was present. He was in poor health and experienced much physical suffering for many years, and in 1939 retired from active scientific work.

WE regret to announce the following deaths:

Dr. T. McFadden, senior demonstrator in physics at the Queen's University, Belfast, on March 25, aged twenty-six.

Dr. H. G. Rule, reader in chemistry in the University of Edinburgh, on March 15, aged fifty-five.

Prof. Warrington Yorke, F.R.S., Alfred Jones professor of tropical medicine in the University of Liverpool, on April 24, aged sixty.

NEWS and VIEWS

Ionospheric Variations during the Sunspot Cycle

IN a lecture entitled "Radio Exploration of the Ionosphere", delivered before the Wireless Section of the Institution of Electrical Engineers on April 7, Sir Edward Appleton described the results of an eleven-year series of ionospheric measurements just completed by Mr. R. Naismith and himself. The work began so far back as 1931, the critical frequency method of measuring the ionization density in the various atmospheric layers being employed (see NATURE, February 7, 1931). Measurements made by this method had not been in progress more than a couple of years before it was suspected that electron concentrations were varying in sympathy with solar activity. The need for continuing the observations for a complete sunspot cycle of just over eleven years was then realized and plans made accordingly. During the course of the cycle, other observers, in different parts of the world, have adopted the same method, and a world survey of the electrical state of the upper atmosphere by means of it is now in progress. The British observations have been made as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research. The ionization in the E and F_1 layers has been found to increase by 50–60 per cent from sunspot minimum to sunspot maximum, indicating a corresponding increase of 120 per cent in solar ultra-violet light, which is known to be the ionizing agency in question. The ionization in the F_2 layer has varied even more markedly, especially in winter. Such a change has an important bearing on long-distance radio transmission, which proceeds by way of ionospheric reflexion. It is now clear that the range of short wave-lengths available for this purpose increases very substantially with solar activity. The international allocation of such wave-lengths for short-wave broadcasting after the War must therefore be based on the ionospheric results obtained during the last sunspot cycle.

The Logic of Question and Answer

In the issue of *Mind* for January 1943, Prof. A. D. Ritchie, under the title "The Logic of Question and Answer", discusses problems connected with the use of hypotheses in scientific method. He begins by denying the existence of 'hard' facts, a denial which should be platitudinous now but is not. A single observation, he argues, does not by itself provide empirical information. This is the function of a plurality of observations in certain relations. He goes on to develop the contention (which he derives from Prof. Collingwood's philosophy) that every proposition which really contributes to knowledge is an answer to a question, and that the question arises out of pre-existing knowledge, this knowledge itself being the answer to a previous question or questions. The fundamental question is always "What have we here ?" If we ask the question about, say, a truck-load of coal, we find the answer by inspecting and testing samples. The number of samples we take and the way in which we take them will depend on knowledge we already possess about the coal, the method in which it is loaded in the truck, whether it is protected from the elements, etc. If we ask how we know that the samples are representative of the material, the answer is that we have chosen a way of sampling which answers the questions we were asking. If our questions are not answered, we must devise another method of sampling.

If all questions depend, in the way stated, on answers to previous questions, we must, it seems, at some point come back to absolute presuppositions. Prof. Collingwood drew this conclusion and further argued that each historical epoch had its own absolute presuppositions. Prof. Ritchie argues, first, that as we trace our questions and answers back we come to a point where what we have is some vague knowledge which is thrown at us by experience with a minimum of questioning and presupposition; secondly, that the presuppositions underlying the process of scientific discovery are purely formal, consist in something like Kant's list of categories, and must be common to all historical epochs because the process of scientific discovery is continuous.

Health Services in Great Britain

The February issue of *Agenda* is noteworthy for an article by Prof. Henry Cohen, "A Comprehensive Health Service". Surveying the various reports on the health services which have followed the P E P report of December 1937, Prof. Cohen stresses the point that medical opinion should be considered expert only in relation to the organization and administration of health services. Questions relating to the various methods of raising the necessary finance are outside its special province. Next, he urges that any plan for the future health service of Great Britain must not overlook the vital factors of provision for the training of personnel (medical education) and of encouraging the advancement of medical knowledge (research). In regard to personnel, Prof. Cohen emphasizes the importance of the general practitioner, who should know not only the patient's body but also his job, his home, his relations. Neither patient nor practitioner should be forced unwillingly into a professional relationship. In addition to this personal relation of medical man and patient, and the maximum freedom of choice, every citizen should have the right to adequate and, so far as possible, the best available provision for the prevention and cure of disease and the achievement of positive health, covering all necessary domiciliary and institutional care, medical and post-medical.

The family should be the unit of health practice ; and the family practitioner must be the focal point of all health services—preventive, educational and curative. Practice must be limited so that it affords adequate rest, leisure and holidays and all opportunities for 'refresher courses', and should be so rewarded that freedom from want for the practitioner and his dependants is secured. The profession should be self-governed and independent of political pressure, and the fullest opportunities should be provided for medical education and research. These general propositions should be assured of much support outside the medical profession. Prof. Cohen also emphasizes the importance of regionalism : the State is too large a unit in medical services, and the local authority too small. What he has to say of teaching hospitals is of close interest to scientific workers other than those who are actually members of the medical profession, and he directs attention to the opportunity of determining the eventual form of the health service of Great Britain which the demobilization of thousands of younger medical men at the end of the War may well afford, by experimenting with different types of health services in different areas.

Biology and Health Education

The importance of biological teaching in the schools as a basis for health education was stressed at a conference held in the City Museum, Leeds, on April 17. This, the first of a series being arranged throughout Great Britain by the Central Council for Health Education, was attended by some three hundred teachers, medical practitioners, youth leaders, social workers and educational and medical administrators. This fruitful co-operation between the two professions most concerned in health education was signalized by Dr. J. Johnstone Jervis (medical officer of health for Leeds) taking the chair during the morning session and by Alderman W. M. Hyman (chairman, West Riding Education Committee) during the afternoon session.

Dr. Robert Sutherland (medical adviser, Central Council for Health Education), speaking on "The Possibilities of Health Education", stressed the importance of the concept of health as a positive state of bounding well-being, rather than as a mere absence of disease. The address on "Health Habits and Hazards" given by Dr. J. F. Galloway (medical officer of health, Dewsbury) made the point that the greatest hope for the health of the future is in the schools. At the afternoon session, Mr. Cyril Bibby (education officer, Central Council) spoke on "The Methods of Health Education", and suggested ways in which parents, teachers, administrators, youth leaders, school doctors, dentists and nurses, health visitors, and by no means least, 'John and Jane Citizen', could co-operate. An open forum provided a very fruitful exchange of views between the various professions represented, and the conference closed with a display of health education films.

Summer School in Biology and Health

The Central Council for Health Education has been able to secure the services of eminent men of science and educationists for its Summer School in Biology and Health, to be held during August 4–14 at the Chelsea Polytechnic, London, under the joint direction of Mr. L. J. F. Brimble and Principal F. J. Harlow. Among the lecturers (subject to war emergency) will be Sir John Russell, Prof. C. W. Valentine, Prof. Winifred Cullis, Prof. J. R. Marrack and Prof. Lancelot Hogben. The mornings will be devoted to lectures by biologists and medical men; the afternoons to seminars, open forums and visits to museums, experimental stations, etc.; during the evenings lectures will be given on "Biology and Health", "Early Childhood", "Problems of Sex Education", "Social Aspects of Nutrition", "Biology as a Social Science", and "Agricultural Developments in the U.S.S.R.". Time will, of course, be left for recreation and social functions.

The first three days of the School should be of interest to all teachers, educational administrators, youth leaders, nursery school and play centre workers, school nurses, and indeed all who have to do with children. The final week will be planned specially for teachers of biology and those interested in that subject. The fee for the first three days only will be two guineas, and for the full ten days five guineas, in each case plus half a guinea registration fee. These figures include lunch, tea and dinner each day. The School has been approved by the Board of Education, and many education authorities will be prepared to consider applications for financial assistance to attend the course. Further details can be obtained from: Mr. Cyril Bibby, Education Officer, Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1.

Rat Infestation on Vessels

Dr. Robert Olesen, medical director, and G. C. Sherrard, acting assistant surgeon of the United States Public Health Service, state that the records available at the New York Quarantine Station since 1924 show a considerable number of fumigations of ships though not an unduly high average of rats recovered from each vessel (*Public Health Rep.*, **57**, 1966; 1942). The influence of war on fumigation of vessels is shown by the fact that since 1940 the number of fumigations has gradually increased, and the average rat recoveries from each vessel have been greater than during previous years. In spite of the losses of trained staff, the Public Health Service maintains surveillance over vessels entering United States ports, though this is becoming increasingly difficult owing to rodent control being submerged by purely war effort.

Silkworm Rearing

We have received a copy of a small publication in paper cover entitled the "Silkmoth Rearer's Handbook", which has been produced as volume 6 of the *Amateur Entomologist* (price 5*s*., postage 4*d*.; from Miss P. L. Rogers, 19 Crescent Road, London, N.8). This little work of seventy-two pages contains four plates of photographs of different silkmoth larvæ and more than twenty text-figures of the moths, their cocoons, etc. It includes instructions on the making of rearing and forcing devices, how to overcome the difficulties of pairing these giant moths and of obtaining fertile eggs, the problems of moulting, pupation and emergence, obtaining initial stocks, hybridization and many other matters of practical value. Sixty-seven species are described in detail, the notes including short descriptions of all stages of many of the species, together with specific pairing and rearing methods, food-plants acceptable in Britain and other information. The book is a reference guide which should prove of interest to all lepidopterists.

The Badger in Britain

The Cumberland Nature Club of Cockermouth is organizing a nation-wide protest against the action of the Cumberland War Agricultural Executive Committee in including the badger in the list of 'vermin' recommended for destruction by the pests officer. The usefulness of the badger's habits has long been accepted in natural history circles, although in game preservation and rural circles it still suffers persecution for the misdeeds of the fox or occasional poultry raids by single individuals. The badger, with the fox and the stoat, is a natural 'brake' upon the rabbit population of the countryside. Its diet comprises fruit, roots, small rodents, contents of wasps' and bees' nests, rabbits, and sometimes small birds on the ground, and decaying animal or vegetable matter.

Polish Institute of Arts and Sciences in America

Further evidence of the indomitable determination of Polish men of science and men of letters to defeat the Nazi plan to destroy the cultural and intellectual life of Poland is given by the publication of the first number of the quarterly *Bulletin of the Polish Institute of Arts and Sciences in America*. As is explained in the introduction, the aim of this bulletin is two-fold. It will serve as the journal of the Institute itself and to replace, for the duration of the War, the *International Bulletin of the Polish Academy*. It contains a history of the struggle for Polish culture up to the foundation of the Polish Institute of Arts and Sciences in America, in December 1941, and gives details of the activities and programmes of the sections of that Institute: historical and political sciences; history of literature and arts; law and social and economic sciences; pure and applied sciences; and educational problems.

Papers and lectures delivered at the Institute (in some cases published both in Polish and English) include the inaugural address given by Prof. Bronislaw Malinowski, first president of the Board, who died suddenly on the following morning; a report by Prof. Oskar Halecki, director of the Institute: "Critical, Pre-Critical and Post-Critical States of Liquid Substances" by Wojciech Świetosławski; and "The Aerodynamical Explanation of Cosmic Vortices" by Gustaw Mokrzycki. A list of books, articles, and reviews published by members of the Institute, not only in the Institute's own publications but all over the world, constitutes a valuable record of Polish contributions to science and letters. Tribute is paid to the many Polish professors, lecturers and other scholars who have died under German occupation or in concentration camps, a record which cannot fail to stir a desire to assist in every way the efforts of those men who are striving to carry on, in Great Britain through the Association of Polish University Professors and Lecturers and in the United States through the Polish Institute of Arts and Sciences, the intellectual activities so essential to the future of their country.

Cooper Union for the Advancement of Science and Art

The eighty-third annual report of the Cooper Union for the Advancement of Science and Art, New York, covers the year ending June 30, 1942, and includes the report of the director, Mr. E. S. Burdell, with the departmental reports of the School of Engineering, the Art School, the Library, the Division of Social Philosophy, and the Division of Business Administration. Dealing with the effect of America's entry into the War upon American education, Mr. Burdell hints that the United States Office of Education may assign a specific training task to each college in terms of its capacity, equipment and personnel. He further predicts the year-round operation of many colleges and particularly of engineering schools. The post-war demand for scientifically trained personnel for rehabilitation and reconstruction purposes promises to be as great as the existing demand for trained men for the armed services. Teaching staffs, however, must not be called upon to face a twelve-month academic year with rest periods on a catch-as-catch-can basis. Colleges which anticipate year-round operation should be prepared to adopt the 'quarter-off' system which already works successfully in the State universities now on a four-semester basis, where a member of the teaching staff may expect his non-teaching semester during any one of the four quarters, which usually correspond to the four seasons of the year.

A third great challenge which American colleges must face during or shortly after the War is in the field of co-operative education. Stressing the way in which the co-operative scheme of alternating school work and shop practice strengthens vocational orientation, and the union of theory and practice, Mr. Burdell points out that the present tendency is for longer periods of alternation between college and the industries and that the most important functionary in the operation of the co-operative system is the co-ordinator. The value of the system has been well demonstrated in the experience of the University of Cincinnati, the pioneer in this movement, and for engineers the system teaches the student to do his best naturally and as a matter of course, as well as affording an appreciation of the human factor in practical affairs. In the second part of his report, Mr. Burdell refers to the question of student health and suggests a comprehensive study of the effects of stress, continuous and prolonged, upon the physical and mental stamina of young adults, which the Cooper Union has under consideration.

Evolution of International Trade

In an address before the Manchester Statistical Society on March 10, on some essential factors in the evolution of international trade, Prof. A. G. B. Fisher stressed the importance, if we wish to maintain or improve our standard of living, of being prepared constantly to adjust our export activities to meet the probable changes in circumstances arising through changes in the character of employment, and of being constantly on the alert to initiate changes on our own account which are likely to be advantageous to us. British export trade flourished during the nineteenth century because we were able to supply people in other countries with things which they were eager to purchase, and he urged a careful study of the figures for total and expanding exports with reference to other exports. We should consider how best we could prepare to make further adjustments after the War which would be suitable in the different conditions of world demand which will then exist. What is more, we should ensure that those adjustments would be made on a scale sufficiently large to assure us that balance of payments equilibrium at which we must aim. He stated that material progress will be impossible unless there is free admission into the occupations and industries where increased production is necessary to provide consumers with the things without which no increase in their real incomes will be forthcoming. Scientific and technical knowledge have always been the most important factors underlying economic progress, so the basis for the adjustments of the structure of world trade which will in any event be necessary is already available for us to build on. Such considerations are already receiving serious attention in other parts of the world, particularly in Switzerland, where Swiss industry is preparing to meet the new demands which peace will bring to it. Many industrial concerns there are strengthening their technical staff and increasing the number of their scientific collaborators, making resources available for research and constructing laboratories.

Ventilation of Electrical Substations

The type of construction used for substations is generally governed by requirements, for example, fire and air-raid precautions, which may conflict with the maintenance of the atmospheric conditions necessary for keeping the equipment in good order. These conditions are not necessarily the same as those needed for human comfort, and the application of heat alone has often been found to be ineffective and costly. In a paper read in London before the Institution of Electrical Engineers, F. Favell and E. W. Connon record their experiences in overcoming substation ventilation problems in particular cases. Adequate and suitably planned ventilation will maintain substation equipment in a satisfactory condition with a far smaller use of heat than has generally been considered necessary. Further collaboration by manufacturers, for example, in designing gear which would be unharmed by the occasional condensation that might occur in an unheated building, might enable heating to be dispensed with entirely. It is not certain that present-day switchgear will be affected adversely by occasional bad conditions, and further investigation of this matter is required. Substation equipment and the buildings housing it should be designed and constructed as a complete unit. The paper discusses the subject under the headings of typical arrangement of a large indoor substation, conditions required in substations, the effects of unsuitable conditions, arrangements of ventilating plant, transformers inside buildings, and application to smaller substations.

Australian Antarctic Expedition

The first volume of the "Scientific Reports (Series A) of the Australasian Antarctic Expedition of 1911–14" has now been published (Sydney, Government Printing Office, 1942. £3 17*s.* 6*d*). The long delay was due to many causes, of which the most important was the usual difficulty that scientific expeditions have to face, namely, lack of funds. This large volume contains 350 pages of text, more than a hundred illustrations and nine maps. The text is mainly the narrative of the expedition by Sir Douglas Mawson, and most of it has been long anticipated by the same author's popular volume entitled "The Home of the Blizzard" and Captain J. K. Davis's "With the Aurora in the Antarctic". Nevertheless, the official record of voyages, sledge journeys and discoveries should be valuable to future explorers. Most important, however, are the maps of various parts of the coast-line of Antarctica showing in full the details of the expedition's work. They include a large-scale plan of the surroundings of the expedition's main base at Cape Denison in King George Land, and maps of Queen Mary Land, King George Land, and the Charnockite coast east of Commonwealth Bay, and also track charts of the several voyages of the *Aurora*. Another useful feature is the inclusion of gazetteers of all names, giving not only the character of the feature, but also the origin of the name. The latter will be most useful for the future historian of the Antarctic. Only too often the origin of names given to features in polar regions is lost for want of such records by the explorers themselves.

Scientific and Industrial Photographers

The Birmingham General Branch of the Association of Scientific Workers arranged for a lecture by Mr. Herbert E. Zerkowsky, of the British Cast Iron Research Association, on April 13, at the Chamber of Commerce, Birmingham, in connexion with the exhibition "Photography in Science and Industry". Mr. Zerkowsky started by giving a review of the development of photographic technique and paid tribute to the research work done by the manufacturers of photographic materials in Great Britain and to the contributions made by those who employ photography daily as a tool, and also by the amateurs. Special reference was made to the question of the alaries of photographers in the Civil Service and in industry, which are generally far below the average pay of those employed in the darkroom and in portrait photography. Mr. Zerkowsky pointed out hat those who use photography for technical and cientific purposes are required to have first-class technical and scientific knowledge besides their photographic skill and experience. These workers, which he suggested should be called 'research photographers', have no organization to look after their interests and to ensure facilities for further studies and training young people, apart from the Association of Scientific Workers. He suggested the formation of a Group of Scientific and Industrial Photographers within the Association.

Potato Virus Diseases in Victoria

Pamphlet No. 110 of the Commonwealth of ustralia Council for Scientific and Industrial Research (314 Albert Street, East Melbourne, Victoria, 941), by J. G. Bald and A. T. Pugsley, considers the fects of the potato virus diseases named *X*, *A*, *Y*, nd leaf-roll, upon the most important varieties of that op grown in Victoria. The variety Carman is almost ntirely infected with virus *X*, is very susceptible o *A* and *Y*, and less so to leaf-roll. Up-to-date, ke its namesake in Great Britain, is susceptible to most of the serious viruses, but in Victoria it possesses practical field immunity from virus *A*. The Snow- ake variety is not very subject to aphis-borne virus seases, though the stock is almost entirely affected with virus *X*. A survey of suitable districts for the propagation of disease-free potato stocks is being made, and further studies of the effects of multiple infection by the viruses mentioned above, and those denoted by *F* and *G*, are in progress.

Palæontographical Society

Tributes were paid to Sir Arthur Smith Woodward on his retirement from the presidential chair at the annual general meeting of the Palæontographical Society held in the Geological Society's rooms at Burlington House on April 21. Sir Arthur had been president for nine years, following thirty years as secretary of this Society. During his period of secretaryship, in addition to the ordinary duties of that office, he contributed two important monographs on Cretaceous fishes to the Society's series of volumes which describe and illustrate British fossils. In recognition of Sir Arthur's outstanding services to the Society, he has been elected an honorary member. He is succeeded as president by Prof. H. L. Hawkins, professor of geology in the University of Reading.

Sir Sidney Burrard

Prof. J. L. Simonsen writes: "In his brief obituary notice in Nature of April 10, p. 414, of the late Sir Sidney Burrard, Sir Gerald Lenox-Conyngham omitted to mention one very important contribution to the advancement of science in India which we owe to Sir Sidney. When the formation of the Indian Science Congress, now the Indian Science Congress Association, was under consideration in the years 1911–12, it is very doubtful if any progress would have been made had it not been for the enthusiastic support which the proposal received from Sir Sidney Burrard and Sir Henry Hayden. It was due mainly to their representations that this body was from the outset recognized by the Government of India and by the local governments. Sir Sidney was president of the Congress at Lucknow in 1916 and during the remaining period of his service in India he always followed its meetings with the greatest interest".

The Night Sky in May

New moon occurs on May 4d. 09h. 43m. u.t., and full moon on May 19d. 21h. 13m. The following conjunctions with the moon will take place: May 5d. 22h., Mercury 8° N.; May 6d. 15h., Saturn 3° N.; May 7d. 18h., Venus 6° N.; May 9d. 21h., Jupiter 3° N.; May 28d. 10h., Mars 2° N. Occultations of stars brighter than magnitude 6 are as follows: May 6d. 9h. 01·0m., α Tau. (*D*); May 6d. 10h. 07·0m., α Tau. (*R*); May 12d. 21h. 27·6m., ν Leo (*D*). The times are given for Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury is stationary on May 12 and in inferior conjunction on May 23. Venus sets at 23h. 30m. about the middle of the month and is a conspicuous object in the western sky. Mars souths at 8h. in the middle of the month, rising at 2h. 30m. The planet is in Aquarius and is rather low for good observation. Jupiter, in Gemini, sets about midnight in the middle of the month. Saturn cannot be seen as it is too close to the sun. The times refer approximately to the latitude of Greenwich. The Aquarid shower of meteors is active in the first week in May, but it is generally very feeble and supplies few meteors.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Absolute X-ray Wave-lengths

In a letter under this title, Messrs. H. Lipson and D. P. Riley[1] have made some suggestions regarding the values of the X-ray wave-lengths to be used in diffraction measurements. All wave-lengths in the X-ray spectra determined by crystal measurements are based on the value $d_1 = 3029{\cdot}04$ X.U. for *the lattice constant of calcite at* 18° and the corresponding values of d_2, d_3 . . . for the higher orders[2]. As secondary standards for the longer wave-lengths, quartz $d_1 = 4244{\cdot}92$, gypsum $d_1 = 7579{\cdot}07$ and mica $d_1 = 9927{\cdot}58$ X.U. have been used. Rock salt, which was used in the very first days of X-ray spectroscopy, was abandoned because the spectral lines obtained with this crystal did not have sufficiently good definition to allow the desired precision in the measurements.

As was first shown by Bäcklin[3], there is a discrepancy between the values of the X-ray wave-lengths from crystal measurements expressed in X.U. and those obtained with ruled gratings. Bäcklin pointed out that this could be explained by supposing that the value of the electronic charge was a few tenths per cent higher than the value commonly accepted at that time. As is well known, the more recent determinations of e have proved the correctness of this view.

Measurement of the X-ray wave-lengths with ruled gratings naturally gives their values in centimetres or Ångstrøm units ($= 10^{-8}$ cm.). Unfortunately, wave-length measurements in this region with ruled gratings do not yet give the same accuracy as those with crystals. As the large number of wave-lengths now determined by the crystal method in X-units form a consistent system, it is in my opinion inadvisable to make a general recalculation of them before we have a sufficiently accurate value for the conversion factor.

From the direct comparisons of some wave-length values determined both with crystals in X.U. and with ruled gratings in A.U. by Bäcklin, Bearden and Thyren[4], a conversion factor of $1{\cdot}00201 \times 10^{-3}$ is derived, with an error of some units in the last place. The X-unit, which then differs from 10^{-11} cm. by very nearly 0·2 per cent, may be retained for the scale employed to express crystal measurements. In the few cases where values in centimetres or A.U. are desired, the conversion factor just given may be used.

Manne Siegbahn.

Research Institute for Physics,
Academy of Sciences,
Uppsala.
March 24.

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[1] Lipson, H., and Riley, D. P., Nature, 151, 250 (1943).

[2] Siegbahn, Manne, "Spektroskopie der Rontgenstrahlen" (2nd Edit., Berlin, 1931).

[3] Bäcklin, E., Dr. Diss., Upsala Universitets arsskrift, 1928; *Z. Phys.*, 93, 450 (1935).

[4] Thyren, F., Dr. Diss, *Nova Acta Regia Soc. Sci. Upsaliensis*, iv, 1 (1940).

We are glad that Prof. Siegbahn has been able to give his attention to this matter, as his opinion is certainly of great weight. The complication has arisen because crystallographers have not obeyed h original instructions to use the X-unit; this is i conveniently small for expressing lattice spacin and it has therefore been the general custom quote all results as though they were in Ångstrø units.

A copy of Prof. Siegbahn's letter arrived in tin to be read at the Institute of Physics conference he in Cambridge on April 10. The consensus of opini was the same as his—that it would be better to wa for a more accurate value of the conversion facto Nevertheless, it seems to us that it cannot be assum that the accuracy will increase with time. Becau the angles involved in diffraction by ruled gratin are necessarily small, it is probable that the accura attainable will never reach that with which t angles of diffraction from crystals can be measure

May we suggest the adoption of the following co ventions? These will lead to factual correctness ar to less confusion when the change to absolu measurements is ultimately made. When an accura not better than 0·1 per cent is claimed, the resu should be given in Ångstrøm units, but for high accuracy it should be given in X-units. Thus t lattice parameter of iron could be given as 2·86 or 2860·4 X., but not as 2·8604 A. The value of t wave-length adopted should always be explicit stated.

It is, however, undesirable to have to use a un or length that is not simply related to the C.G. system, and we are still of the opinion that t X-unit should be eliminated as soon as possible.

H. Lipson.
D. P. Riley.

Cavendish Laboratory,
Cambridge.

Renal Excretion of Pituitary (Posterio Lobe) Extracts

It is somewhat puzzling to notice that J. Shannon on p. 312 of the latest (1942) volume of t "Annual Review of Physiology" regards it as esta lished that the kidney can excrete the antidiuret principle of the posterior pituitary lobe, whereas J. Peters on p. 110 of the same volume appears to rega this as at least extremely doubtful. In neither case the conclusion supported by a full reference to t work published on the subject. It may, therefore, worth while to enumerate the papers concerned wi the renal excretion of posterior pituitary extracts the hope that such a survey will clear the issue.

After intravenous injection of posterior pituita extracts, renal excretion of an antidiuretic activi has been observed in rats[1], rabbits[2] and dogs[3]. The results can be supplemented by those of Dale[4], Jon and Schlapp[5] and Larson[6,7], who reported the eli ination of a pressor and an oxytocic activity aft intravenous administration of posterior pituitary e tracts. Opinions about the result of subcutaneo injections of posterior pituitary extracts are le unanimous. Gilman and Goodman[8] and Ingra Ladd and Benbow[9] reported the urinary excreti of an antidiuretic activity after subcutaneous i jections of large doses of posterior pituitary extrac into rats and dogs respectively. However, Walker experiments[10] were positive in only two out of te experiments on rats.

Summing up, there is satisfactory agreement th the kidney of all mammalian species investigated ca excrete the posterior pituitary principles provided that the extract is administered intravenously and in sufficiently large amounts. All observers agree further that a fraction only of such large amounts finds its way into the urine and that the bulk of any activity is excreted within the first hour after injection. There is no doubt, therefore, that Shannon's conclusion as to the ability of the mammalian kidney to excrete the antidiuretic hormone is well supported.

However, Peters, in discussing the evidence for the renal excretion of posterior pituitary extract, says: "He [Walker[10]] was unable to detect pituitrin in the urine of rats after injection of the drug, in direct contradiction of the claims of Heller (1937)". He quotes no other papers and, in fact, his reference to the contested experiments is erroneous. They were not published by Heller in 1937 (*J. Physiol.*, **89**, 81) but by Heller and Urban in 1935 (*J. Physiol.*, **85**, 502). It may therefore be suspected that he failed to appreciate the difference in the conditions of the experiments. Heller and Urban injected posterior pituitary extract *intravenously* whereas Walker administered pituitrin by *subcutaneous* injections. To talk of "direct contradiction" seems therefore inadmissible, even if Walker's positive results in two of his experiments are neglected. There is ample evidence (see above) that a large fraction of intravenously injected posterior pituitary extract is inactivated in the body, and the *in vitro* experiments of Heller and Urban[1], Jones and Schlapp[5] and Larson[6,7] suggest that an enzymatic process is involved in this inactivation. It seems therefore reasonable to assume that, in the case of a preparation like posterior pituitary extract which blocks its own absorption from the subcutaneous tissue, considerably less will be excreted after subcutaneous than after intravenous injection. Considering the large doses used, this may be taken to mean that the blood concentration of he hormones has to be high to ensure excretion of sizable amounts in the urine. It is clear that a sufficiently high blood-level is less likely to be reached after subcutaneous injection.

The apparent discrepancy between Walker's and Heller and Urban's results would seem to be well explainable on this basis. However, it was decided to re-investigate the problem of the renal excretion of posterior pituitary extract by rats. Experimental onditions, so far as the dose of posterior pituitary extract and the mode of administration were concerned, were the same as those of Heller and Urban's[1] eries, with the exception that the urine excreted by the rats injected with the posterior pituitary extract was not used as such but was adjusted to represent equal excretion periods of a control series of rats receiving only water. In another series the urines were adjusted to the same pH and specific gravity. Burn's method was used to test urines for antidiuretic activity. The following experiment may serve as an xample.

Two rats received 1,500 mU. of posterior pituitary extract, B.D.H., by intravenous injection and 5 per ent of the body-weight of tap water by the mouth; wo others received water only. The urine of these animals was collected up to 3 hours after water had been given, and the urine of the 'pituitary exact animals' (urine *A*) diluted to the same volume as that of the controls (urine *B*). Two groups of two rats were injected subcutaneously with 2·5 ml. per animal of urine *A* and two other rats with 2·5 ml. per animal of urine *B*. The times required to reach the 'mid-excretion point' were 300 and 270 min. for rats injected with urine *A*, and 90 min. for those injected with the control urine *B*.

Leaving the quantitative aspect of the problem aside, there can therefore be little doubt that *some* fraction of the intravenously injected pituitary extract appeared in the urine of the rats as an antidiuretic activity. The experiments of Heller and Urban[1] were thus fully confirmed.

H. Heller.

Dept. of Pharmacology,
University of Bristol.
April 5.

[1] Heller, H., and Urban, F. F., *J. Physiol*, **85**, 502 (1935).
[2] Heller, H., *J. Physiol.*, **89**, 81 (1937).
[3] Hare, K., Hikey, R. C., and Hare, R. S., *Amer. J. Physiol.*, **134**, 240 (1941).
[4] Dale, H. H., *Biochem. J.*, **4**, 427 (1909).
[5] Jones, A. M., and Schlapp, W., *J. Physiol.*, **87**, 144 (1936).
[6] Larson, E., *J. Pharmacol.*, **62**, 346 (1938).
[7] Larson, E., *J. Pharmacol.*, **67**, 175 (1939).
[8] Gilman, A., and Goodman, L., *J. Physiol.*, **90**, 113 (1937).
[9] Ingram, W. R., Ladd, L., and Benbow, J. T., *Amer. J. Physiol.*, **127**, 544 (1939).
[10] Walker, A. M., *Amer. J. Physiol.*, **127**, 519 (1939).

Terminology in the Geological Sciences

Dr. R. H. Rastall has stated his views concerning the ordinary educated citizen's lack of appreciation of the geological sciences[1]. At least a warning note has been struck. *Verbum satis sapienti.*

The unpopularity of biological science is attributable to various causes. The present century has witnessed a steady decline in the number of versatile amateur naturalists. True, the progress of science has involved complication of its fundamental alphabet and this, together with the ever-expanding literature, has invoked specialization, but it is doubtful whether this has embarrassed the would-be amateur. The amusements and social distractions of recent decades have robbed science of potential workers before they envisaged the complexity of nomenclature.

The usual course in geology for engineers and others is not calculated to perpetuate a love for the science. The fault lies in an unbalanced curriculum, which represents geology as a dull description of inanimate specimens. The average course in stratigraphy for the would-be professional geologist is destined to depress, but here the method of teaching is at fault.

Dr. Rastall blames the palæontologists. They have, however, made some progress despite the multiplying of names. We only need instance the work of Bisat, Trueman and Elles, and the resulting advances in Carboniferous, Silurian and Ordovician stratigraphy.

The subdivision of 'aristocratic' genera is frequently advisable, but the field-worker need concern himself only with trivial names; these are irrevocable unless they contravene the International Zoological Rules. Concerning the laws of priority, Dr. Rastall's 'sleeping dogs' might awaken at awkward moments. Such laws are essential if biological nomenclature is to avoid international chaos. Nothing is more troublesome than an obscure and undeciphered synonymy. Again, owing to possible synonymy, quotation of the author of a trivial name is utilitarian, though it could well be omitted from popular accounts.

Dr. Rastall states, "petrology and mineralogy get on very well without such a system". The problems confronting biological and mineralogical or petrological classification are scarcely comparable. Biology deals with necessarily variable material. Mineralogy and petrology are concerned with minerals which normally possess definite chemical compositions. The mineralogist would indeed be faced with the biological problem if his minerals were always members of isomorphous series, vastly more numerous than they actually are, and if they changed composition from horizon to horizon throughout the succession.

The palæontologist is necessarily at a disadvantage as compared with the student of living material where the species concept is concerned. The biologist can test a questionable case whereas the palæontologist can but judge the taxonomic value of observable characters.

It seems improbable that geological science will ever become popular, but better early education in general science, revision of university curricula and more flexible teaching at the university stage would do much to satisfy any future demand for geologists. Additionally, it would seem advisable to establish a Central Bureau of Geological Research, where research could be registered to obviate wasteful overlapping, and to which workers contemplating original views or institution of new names could state their reasons before publication is allowed.

F. Wolverson Cope.

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250 Oxford Road,
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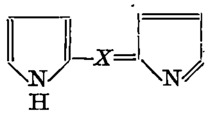
[1] Nature, 151, 294 (1943).

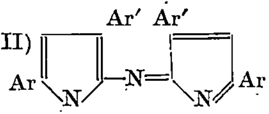
Tetra-arylazadipyrromethines: a New Class of Synthetic Colouring Matter

When two resonant systems can be linked by a methine bridge to form a single degenerate system, it is usually found that the methine bridge can be replaced by a bridge consisting of a single nitrogen atom, the resulting *aza* compound being at least as stable as the methine itself; the progressive replacement of the methine bridges in the porphins to form *aza*-porphins, and finally phthalocyanines, being an interesting example. It is therefore surprising that, despite the numerous examples of the class $5:5'$-dipyrromethine (I, X = CH), there is no record of a $5:5'$-*aza*-dipyrromethine (I, X = N).

(I)



(II)



Examples of this class of compound have now been made, the pyrrole rings being substituted by aryl radicals in the $2:4$-positions (II). Two general methods have been used. In the first, the $2:4$-diarylpyrroles (made by dehydrogenation of the pyrrolines, methods of preparing which are described in the literature) were converted into their 5-nitroso compounds, which condensed readily with the α-position of a second molecule of the pyrrole. The second method is a very remarkable one, the *aza*-methine being obtained by the action of formamide, or certain other simple ammonia-donating substances, on compounds of the type:

$\mathrm{ArCH(CH_2NO_2)CH_2COAr'}$ or $\mathrm{ArCH(CN)CH_2COAr'}$.

The reaction is complex, but some insight has been obtained as to the steps involved, which will be published elsewhere with the full details of this work[1].

The *aza*-dipyrromethines fulfil expectations as to colour and stability. The simplest member of th series which has been made is $2:2':4:4'$-tetraphenyl *aza*-dipyrromethine (II, Ar = Ar′ = Ph), an intensel blue compound which sublimes with but little decomposition when heated in air, and with no decomposition when heated *in vacuo*. The *aza*-methine form metallic complexes analogous to those forme by the true methines, including $2:2':4:4'$-tetraphenyldipyrromethine itself, which is, as would b expected, red.

My thanks are due to I.C.I. (Dyestuffs), Ltd., fo permission to publish this letter.

M. A. T. Rogers.

Research Department,
I.C.I. (Dyestuffs), Ltd.,
Blackley,
Manchester, 9.
March 30.

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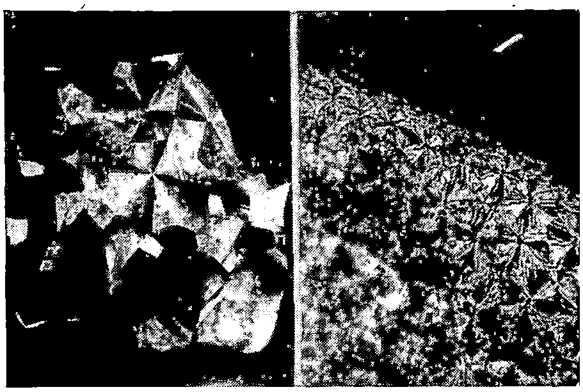
[1] Patent applications pending.

Occurrence of Crystals in the Skin of Amphipoda

The difficulty in distinguishing some of the specie of Amphipoda suggested that some means other tha the usual ones of comparison of parts might be tried after trying various chemical and physical tests examined the skins in polarized light. The result achieved seemed at first sight to indicate that th method might be of considerable value. Unfortunately it was not found possible to separate specie by this method.



a b

Crystal development in the skin of *Leucothoe spinicarpa*. (*a*) Crystals at posterior end of body 5 min. after moulting; (*b*) Arborescent pattern.

In general, the Amphipoda load their skins wit crystals of calcium carbonate, which is laid down i the form of radiating needles. These crystals do no always give the same effect in polarized light so tha it is possible to separate some families thereby, fo example, the Gammaridæ and the Leucothoidæ. Th crystals in the skin of the former between crosse Nicols show alternate dark and light wedges meetin at their apices (Fig. *a*). In the latter, the dark an light wedges are broken up into an arborescent patter of dark and light lines (Fig. *b*).

More surprising still is the fact that though crystal are found in the skin of Gammaridæ taken from suc extremes of environment as the sea and water o pH 4·8 (as in Lough Sure, Donegal), the Talitrida contain no crystals at all, yet many of them liv under conditions apparently similar to those of th gammarids.

The presence or absence of crystals, then, seems to bear no particular relation to the environment of the animals. Is it possible that the hardening of the chitin has to be done by calcium carbonate if the usual nitrogenous material is not available? It can scarcely be because the calcium is only occasionally available.

Another interesting point is that all members of the same family do not necessarily behave in the same way. Thus some of the Dexaminidæ, Aoridæ and Photidæ have crystals and some have not. (It has to be noted that, while the skin of *Leptocheirus pilosus* Zaddach shows no structure, that of *L. hirsutimanus* (Bate) shows a reticular network similar to that of *Amphithoe rubicata* (Montagu). This, however, is a matter quite distinct from that of the crystals.)

The rate of crystal deposition in newly moulted individuals is extremely rapid. *Gammarus pulex* (L.) kept in normal tap-water in the laboratory showed the usual crystals in the newly moulted skin. This process was watched, and five minutes after its completion the animal was killed and its new skin examined. It was found that the crystals were well developed, especially towards the posterior end of the animal (see Fig. *a*). Anteriorly, crystallization was not complete—the crystals were in the growing stage; the growth had started from centres and was passing outwards. At the edge of the piece examined the crystals had reached their normal size, but away from the edge the crystals growing from their centres had not met. Twenty-four hours after moulting, the skin had a complete layer of crystals which, however, does not mean that no more deposition would take place.

The time necessary for calcification seems to be much shorter than that suggested by Schumann[1], who estimated it at seventy-two hours after moulting.

I can find no evidence to show that calcium is withdrawn from the skin before moulting takes place. Therefore, unless it is stored in some other part of the body, the calcium necessary for the new skin must be drawn from the water or from the food-plants. It has been impossible to get samples of either from Lough Sure, but specimens of water, weed and *Gammarus pulex* from an acid loch in Inverness-shire showed that, though the water was pH 6·2 and the hardness 2·7 parts of calcium carbonate per 100,000 of water, and the calcium reckoned as $CaCO_3$) in the plants was 2·05 per cent, there were crystals present in the Gammarus. Thus, hough the water contained little calcium, the food-plants contained an abundant supply. Allowing for the other possible salts present (for example, those of sodium, potassium and magnesium) the concentraion of $CaCO_3$ may well be below the solubility of his salt in neutral waters.

It has also been noticed that individuals of a pecies taken from the south coast of England may have crystals, while those of the same species taken rom the north of Scotland may be without crystals. This has been found in the case of *Calliopius crenulatus* Chev. and Fage, and *Nototropis schwammerdami* M.-Edw.).

It is hoped to return to these investigations when conditions return to normal.

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[1] Schumann, F., *Zool. Jahrb.* (*Physiol.*), 44 (1928)

Winter Sources of Vitamin C

In view of the scarcity, in Great Britain, of vitamin C from natural sources during the months of January, February and March, it is suggested that the following analytical data on small, hardy plants may be of some interest in problems of human nutrition. The plants were examined under the same conditions and compared with two samples of watercress purchased in the open market.

Vitamin C was determined by titration with 2 : 6 dichlorophenol indophenol, and the results shown in the accompanying table were obtained:

	Sample	Classification	Date analysed	Vitamin C as ascorbic acid per 100 gm. of fresh material
1	Australian cress	*Lepidium* (? *sativum*)	March 4	148 mgm.
2	American cress	*Barbarea verna*	March 31	108 mgm.
3	Italian corn salad	*Valerianella eriocarpa*	March 4	93 mgm.
4	Nüsslisalat (Swiss)	*Valerianella olitoria*	February 18 and March 23	55 mgm. 84 mgm.
5	Watercress	*Nasturtium officinale*	February 13 and March 4	37 mgm. 54 mgm.

In addition the Nüsslisalat and Italian corn salad were tested for riboflavin by the microbiological method of Snell and Strong, and were found to give a positive response to the growth of *Lactobacillus Casei* ε under the prescribed conditions of the test, though we are not prepared at this stage to give definite assay figures for these samples.

The seeds of the two cresses and the Italian corn salad were bought some years ago in Great Britain, and are most prolific when grown in garden soil and well established. The Nüsslisalat was obtained by Miss V. Crowe from the Bernese Oberland, where it grows all the year round and is a constant ingredient of winter salads. It is easily grown here and flourishes during the hardest winters.

Although Nüsslisalat and corn salad have a somewhat lower vitamin C content than the other plants, it would be possible to eat larger quantities of them as they lack the pungency of the cresses. All these plants have a good flavour and compare very favourably with watercress, which is the only really cheap salad plant available during the winter months. They have the undoubted advantage of not requiring special methods of culture and could be grown in odd corners and small gardens.

We are aware that some of the species examined are members of the natural British flora and hope to have an opportunity of examining related wild species. Dr. J. Ramsbottom of the British Museum (Natural History), and Dr. Coke of this clinic, kindly supplied the information as to nomenclature of these plants.

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ENID A. M. BRADFORD.

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April 14.

X-RAY ANALYSIS IN INDUSTRY

THE second X-ray conference of the Institute of Physics was held in Cambridge during April 9 and 10. Sir Lawrence Bragg was in the chair, and in his opening address he particularly welcomed the foreign men of science present, and warm applause followed his greeting to Prof. V. M. Goldschmidt.

In the first session the relative advantages of the powder method with cylindrical and flat specimens were discussed. Dr. A. J. Bradley pointed out the necessity for the accurate measurement of intensities of spectra for determining structures, for investigating superlattices, for examining strained crystals, and for finding temperature factors and atomic scattering curves. The practical difficulties are not great when the spectra are well separated, but when there are many lines close together there are difficulties in finding the background. Dr. Bradley showed some examples in which the background has to be estimated from the values on either side of a group of lines, and he described the design of the photometer with which the curves were obtained. The main theoretical difficulty is the correction for absorption, and for a cylindrical specimen the calculation of the correction is very complicated; Dr. Bradley gave an outline of the method by which he has solved the problem.

Dr. G. W. Brindley pointed out that the absorption correction is more easily dealt with if a flat specimen be used. Nevertheless, the method is not popular, because certain reflexions do not reach the film and the focusing is poor except on one part of the film. This latter property can, however, be used to increase the accuracy; by making the weakest line the sharpest, the peak intensities of the lines can be brought nearer together and so kept within the range of linear response of the film. Not only is the absorption correction simple, but also the absorption coefficient does not enter into the calculation of relative intensities.

Dr. Brindley described the construction of a flat-specimen camera designed to expose two specimens alternately, and explained how absolute intensities can be measured by means of a standard such as aluminium. He showed some results of measurements on potassium chloride, copper and cold-worked rhodium and copper.

Prof. J. M. Robertson spoke on the measurement of the intensities of spots on single-crystal photographs. He said that, while visual estimates of intensities can often be used to fix atomic parameters with surprising accuracy, it is sometimes important to obtain more exact data. He recommended the use of very small specimens, and the reduction of the background with moving-film cameras or by crystal-reflected radiation. There is still difficulty in comparing intensities over a range of about 3,000 : 1, and the comparison of the β-spots of the strong reflexions with the α-spots of the weaker ones can be used to overcome this. The presence of β-spots is, however, undesirable for other reasons, and alternatively one can use a shutter that allows the lower orders to be exposed for only a certain fraction of the total time of exposure. A still simpler method is to expose five films together in series so that each spot is recorded in five known ratios. The stronger spots on the last film can then be compared with the fainter ones on the first. Prof. Robertson gave some of the practical details to be taken into account in this method.

In the ensuing discussion, Dr. W. Hume-Rothery directed attention to the possibility of film shrinkage during exposure, and said that in order to overcome it he finds it necessary to store his film at constant humidity and to maintain this humidity in the camera. Errors in lattice parameters can be overcome by fixing the films near the high-angle ends, but this may affect the measurement of the low orders. Mr. H. P. Rooksby and Dr. A. H. Jay recommended that the films should be stored in a lead-lined box near the X-ray tube, but Dr. Hume-Rothery said that he has not found this satisfactory.

In the evening, Mr. C. W. Bunn gave a lecture entitled "Towards Atomic Photography". He spoke on the problem of producing images of atoms. A magnification of at least 10^7 would be required and the resolution would have to be great in proportion. Abbe's treatment of the resolving power of a microscope, however, leads to the conclusion that the waves used must be smaller than the details one wishes to see, and visible light is therefore much too coarse to detect atoms. X-rays have much smaller wave-lengths, but they cannot be effectively refracted in order to form an image. A beam of electrons, however, also has a short wave-length and can be refracted by electric or magnetic fields. This has led to the construction of the 'electron microscope', with which large molecules can be resolved. But this instrument is still far from being able to detect single atoms.

The formation of an image by optical methods can be resolved into the formation of a diffraction pattern, and the subsequent recombination of the diffraction spectra to form a final image. It is easy enough to get a diffraction pattern with X-rays, but we cannot continue with the second process. It is possible, however, to collect the X-ray diffraction data and to perform the second process with light. Unfortunately, it is not possible to measure the phases of the X-ray spectra, and Mr. Bunn showed how this affects the results in the case of the image of a regular object in a microscope; as the microscope is racked back the image changes, but there is always some detail that might be mistaken for the real image. In some special cases the difficulty can be overcome, and Mr. Bunn showed a copy of Sir Lawrence Bragg's photograph of the atoms in diopside, $CaMg(SiO_3)_2$.

Mr. Bunn also showed some further developments of the application of optical methods to structure analysis, such as the determination of structure amplitudes by what he termed the 'fly's eye' method. A regular array of pin-hole images is formed photographically; the diffraction pattern of the structure to be examined then gives a complete zone of spectra, and this may be compared with the observed X-ray spectra. In a similar way we can find the effects of faults in a structure when this cannot be done by calculation.

The third session began with a discussion of the proposal to change X-ray wave-lengths to absolute values. Dr. H. Lipson explained that the current Ångstrøm unit is now known to be in error by 0·2 per cent and suggested that it should be corrected. He read a letter from Prof. M. Siegbahn [see p. 502] who suggested that the question be deferred until the error has been determined more accurately. This seemed to be the general view, and Mr. Rooksby suggested that a change should not be made without international agreement on the conversion factor. Sir Lawrence Bragg therefore proposed that the question be raised with the American Society for X-Ray and Electron Diffraction, and this was agreed to.

Then followed a series of papers on recent developments. Dr. A. H. Jay explained the significance of the formation of superlattices in alloys, and explained how they can be detected by X-rays. He stated that the formation cannot be regarded as a phase change because there is no radical change in structure.

Dr. Kathleen Lonsdale, who spoke on "Thermal Effects and Allied Phenomena", showed some slides illustrating the decrease in intensity of the main reflexions with rise of temperature, and the corresponding increase in intensity of the 'diffuse' reflexions. These reflexions may be regarded as arising in the following way. X-rays have such a high frequency that from their point of view all the atoms are stationary, although owing to thermal motion they may be displaced from their mean positions. Each of the elastic waves in a crystal can be regarded as producing a superlattice, and it is the combination of large numbers of superlattice reflexions that produces the diffuse reflexions.

Dr. Lonsdale emphasized the usefulness of the concept of reciprocal space for the study of this effect in particular and crystal structures in general, and showed how beautifully the fine detail can be explained by the theory. Jahn's formula for the isodiffusion surfaces has been verified experimentally on lithium, sodium, lead and tungsten single crystals, and it may soon be possible to find the elastic constants of a substance by this method.

Dr. Lipson introduced the subject of "Side-Band Formation" by saying that it is an example of a phenomenon for which the theory had been worked out many years previously to its discovery. In brief, the side-bands are essentially the same as *one* of Dr. Lonsdale's elastic waves 'frozen in', but in this case the wave is due to the incipient separation—in an alloy of copper, iron and nickel—of two phases similar in structure to the parent phase, but with different lattice parameters. Dr. Lipson also showed how the positions of the side-bands can be satisfactorily accounted for in reciprocal space, and that the wave-length and direction of the periodic variation can be found in this way. The intensities do not agree with the theory, however, without a correction for extinction; he thinks that the extinction effect was not given sufficient prominence during the first day of the conference.

Dr. Lipson then showed some results obtained by Dr. Vera Daniel on the decomposition of an alloy with time, and said that entirely new information about phase changes is being obtained.

In the discussion, Sir Lawrence Bragg remarked that the structures that give the side-bands are promising objects for the electron microscope. Mr. K. Hoselitz pointed out that the information is just that needed for the correlation of coercivity and crystal structure, and Dr. Lipson agreed that it would be useful to make the necessary magnetic measurements. Mr. H. J. Goldschmidt said that he had observed a similar phenomenon in certain magnetic alloys.

Prof. Goldschmidt spoke of photographs of radioactive deposits that have been disintegrating for about a million years, and said that they show imperfections because of the recoil of the uranium atoms. Dr. P. P. Ewald directed attention to the similarity of Dr. Lonsdale's work to the examination of the diffraction of light waves by a crystal carrying ultra-sonic waves. He also asked about the effect of a periodic variation of the structural parameters of a crystal, but Dr. Lonsdale said that such effects would appear too far from the reciprocal lattice points to be easily detected. The question of whether superlattice formation should be included on equilibrium diagrams was raised by many speakers; Sir Lawrence Bragg gave his opinion that it is not necessary to discuss whether the formation is a phase change or not, as now that we know the exact nature of the change it does not matter what name is given to it.

The last part of this session was devoted to a report on the preparation of the X-ray index proposed at the meeting held at Cambridge last year. Dr. A. J. C. Wilson presented the report; he gave a brief history of the index and explained the exact nature of the collaboration between the various bodies concerned.

At the opening of the final session, Dr. C. Sykes reported a resolution by the organizing committee that an X-Ray Crystallography Group of the Institute of Physics be formed. After assurances that the group would welcome chemists and others and was only to be regarded as a temporary measure, the resolution was carried.

The main subject of the final session—"Quantitative Treatment of Line Broadening"—was introduced by Dr. F. W. Jones. He showed that the problem of estimating line breadths is complicated by the broadening due to other causes such as the divergence of the X-ray beam and the geometry of the camera. He explained his method of using a standard substance which gives no diffraction broadening, so that, by suitable treatment, this part of the broadening can be allowed for in the broadened lines. He pointed out that this method is unreliable when the diffraction broadening is small compared with the geometrical broadening.

Dr. Wilson spoke on "The Effects of Distortion and other Imperfections". Among the possible causes of line broadening he listed small particle size, heat motion, 'mistakes', and distortion due to cold work. The broadening due to heat motion is different in appearance from the others; Dr. Lonsdale's diffuse reflexions are a manifestation of it. 'Mistakes' are errors in the building up of a lattice, and have been found in hexagonal cobalt, chrysotile, and $AuCu_3$. The theory of mechanical distortion is far from complete, and on account of the difficulties, which Dr. Jones mentioned, of estimating the actual diffraction broadening of the spectra, it has not been found possible to settle unequivocally whether the broadening due to cold work is primarily due to fragmentation or to variation of lattice parameter. The experimental evidence tends towards the latter, and the differences between the various spectra can be satisfactorily accounted for in terms of elastic anisotropy.

In the discussion, Dr. Brindley pointed out that his results are in agreement with this view, and said also that the amount of extinction present in some practical cases cannot be accounted for if the crystals are very small. Dr. W. A. Wood, however, presented some new results which, he claimed, support his theory of fragmentation. On the other hand, Dr. E. Orowan showed a photograph from a bent wire, and another from the wire when it had been straightened, and said that these led to the other conclusion.

This discussion, on the whole, provided the best illustration of how such conferences help in allowing the exponents of different theories to state their views to each other, and in bringing their differences into relief so that the points to be settled can be more clearly seen.

An exhibition of apparatus and films was arranged by Dr. Wilson with the main purpose of illustrating points in the lectures. For example, the Cambridge Instrument Company showed photographs of its latest types of microphotometer, and Dr. Bradley's laboratory produced a set of powder cameras the diameters of which vary from 2·5 cm. to 35 cm.—a graphic demonstration of the way in which this type of camera has developed in the last twenty years.

Mr. Bunn showed some photographs illustrating the method of evaluating structure-amplitudes optically. Sir Lawrence Bragg's 'X-ray microscope', which may be said to have heralded this tendency to return to optical principles for solving crystal structures, was also on view, and was used to show diffraction by a three-dimensional grating as well as several of the effects described in Mr. Bunn's lecture.

In connexion with the papers on "Recent Developments", photographs from superlattices were exhibited; Dr. Lonsdale showed a beautiful series of prints of her 'diffuse reflexions', and Dr. Vera Daniel showed some of the photographs with which the 'side-band' effects have been studied.

The discussion on "Line Broadening" was illustrated by an exhibit by Mr. A. R. Stokes showing the broadening caused in the several ways enumerated by Dr. Wilson. In addition, Dr. D. P. Riley produced a series of photographs of coals taken with crystal-reflected radiation. These photographs show a spreading of the central beam—'low-angle scattering'—that can be correlated with the actual particle-size in the specimen, as distinct from the crystal size that most X-ray measurements produce.

There were several other exhibits of general and metallurgical interest, and as a practical example of the working of an X-ray laboratory the Crystallographic Laboratory of the University was also open for inspection.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

THE twenty-second annual report (E.R.A./T.331) of the British Electrical and Allied Industries Research Association summarizes the work which has been carried out during the year ended September 30, 1942, and, like its predecessor, lists by titles the various research reports which have been issued during the period. The work is reviewed under eighteen major classifications, among which, as was pointed out on the previous occasion, are again the important ones of dielectrics, cables and overhead lines, electric control apparatus, steam-power plant and condensers, magnetic materials, transformers, surge phenomena and rural electrification.

The report shows that the work of the Association is now carried on by 112 technical sections, subcommittees and panels comprised of technicians and scientific workers engaged in industry and in universities and other training institutions. Fifty-seven technical reports on a variety of subjects have been issued by the Association during the year, and fifty-one others were in an advanced stage of preparation at the end of the year. These may be divided as follows, giving, in each instance, first new reports and, secondly, reports in preparation: dielectrics, 20, 15; cables and overhead lines, 8, 4; electric control apparatus, 15, 16; steam-power plant and condensers, 2, 2; communication interference, 3, 2; magnetic materials, 2, 2; transformers, 0, 1; surge phenomena, 4, 3; safety problems, 0, 3; rural electrification, 1, 1; transformer noise, 2, 2.

The Information Bureau has been particularly active during the year, and Government and Service Departments are now making increasing use of its services. The Association's card index now contains nearly 30,000 special references, and current matter is being added at a substantial rate. The first half of the complete analytical index to the contents of E.R.A. reports, covering electrotechnical materials, has now been completed. Close co-operation has been effected with the British Standards Institution in connexion with the electrical engineering section of the Universal Decimal Classification and with the Institution of Electrical Engineers in connexion with *Science Abstracts*.

The work of the Association has outgrown the capacity of the Perivale Laboratory in spite of the large amount of work which is still carried out by other bodies under its auspices, and this now necessitates removal of the laboratory to another site.

The E.R.A. is largely employed in finding specific answers to clearly formulated questions, and the former are of immediate value. Even more important contributions are being made by the E.R.A. in those fields in which the need for guidance is foreseen but the questions cannot yet be clearly put. It may take the industry many years to absorb a result of researches of the latter type, because this may involve a minor revolution in outlook and practice. Certain researches in hand fall definitely into this category; for example, some of those concerned with the phenomena of arcing, dielectric phenomena, properties of circuits, interference with communication circuits, surge phenomena, transformer design, magnetic materials and surface tension.

Notwithstanding the pressure of direct war work, serious fundamental research on dielectrics has been maintained. Industry in war-time has co-operated with and utilized the E.R.A. in dealing with many immediate problems affecting the successful utilization of particular insulating materials.

Of prime interest to the electricity supply industry are the long-range researches designed to increase the reliability, efficiency and safety, and heighten the performance, of plant used for the generation and distribution of electric power. The larger part of the work done falls within this category, and is linked closely with the user interest. Work on problems of electricity supply technology has been brought into increased activity and, in general, co-operation with authorized undertakings has been increased.

The investigation of breakdowns of plant and the devising of steps for prevention of the recurrence are the responsibility of engineers immediately concerned but in so far as they generally involve surge phenomena, phenomena of arcing and questions of the properties of circuits, members can consult the E.R.A. Such work is not only of benefit to the member concerned but also benefits others similarly situated, and assists the investigators in establishing a true perspective as to the needs of the industry.

Continuous progress has been made in establishing liaison with all concerned with post-war reconstruction in the field of agriculture, and there has been increased appreciation of the contributions that the E.R.A. is making.

AGRICULTURE AND WORLD NUTRITIONAL NEEDS

PROF. J. R. MARRACK delivered on April 16 the third of a series of lectures arranged by the Harpenden Branch of the Association of Scientific Workers on "Agriculture and World Nutritional Needs". On the subject of "Food, Relief and Reconstruction", Prof. Marrack said that at the best, supply of food in the continent of Europe when fighting ceases will be as low as in November 1918. It is quite probable that the Nazis will spoil and lay waste large areas and leave the population completely destitute. The provision of adequate relief will be limited by two factors, namely, transport and supplies. The transport problem will be particularly acute, when a considerable area of Europe has been freed and fighting still continues, as transport will still be supplying the Army. When fighting has ended in Europe shipping will still be needed to carry supplies on the long voyage to the Far East. The problem of supplies will become most acute when the whole of Europe is freed. Nearly 500 million people will need to be provided with at least one third of their calories. It may be possible to accumulate stocks to meet this need; but they will be even shorter of animal foods than of total calories, and there is little prospect that stocks of suitable foods will have been accumulated. Pork products, large amounts of which will be available, are mainly fat and do not meet the need for protein.

Vitamin deficiencies will not be equally distributed. There should be sufficient supplies of concentrated preparations (with the exception of riboflavin) for treating the more severe manifestations of vitamin deficiency, but not for indiscriminate broadcast.

It is obvious that during this period of extreme shortage, which will last up to the next harvest, production, transport and distribution of food must be controlled and rationing of individual consumption may be more severe than it is now. But the shortage, particularly of animal foods, will continue for some years, and if we set out to abolish the fear of want we must aim at changing the character of the world's food supply. On the average, it provides enough, or nearly enough, calories; the fault is lack of animal foods, fruit and vegetables. Until a change in the type of food produced has taken place, it will be essential to maintain the supply of calories, at least. Otherwise peasants will continue to wring the maximum number of calories from the soil by cereal culture. The change in diet aimed at is qualitative. But the change in food production is, in the end, quantitative, since animals are poor converters and it takes ten or more calories of feeding stuffs to produce one calorie of human food.

For the immediate future we must accept the distribution of the world's population, with densely populated and sparsely populated areas. Production should be planned to ensure that the densely populated areas produce the perishable animal and vegetable foods for their own consumption and import the portable cereals from the sparsely populated areas. To ensure that the food is produced as needed and that those who need it can buy it, it will be necessary to have a Supreme Economic Council that will control production and distribution and will adjust purchasing power to requirements.

LOCUSTS AND OTHER MIGRATORY INSECTS IN INDIA

IN a land of continental features like India there are major insect pests which have the capacity of spreading from one part of the country to another. Where such pests appear more or less regularly and are of relatively confined distribution the provincial entomologists should be well fitted to study them and devise control measures. In the case of the desert locust, for example, swarms may appear in the Punjab, the United Provinces and Rajputana, and are known to have been derived from outbreak areas in Baluchistan, Iran and Arabia. Similarly, locusts from Rajputana and the Punjab may migrate as far afield as Assam and Madras. It will be clear that, in such cases, the provincial entomologist would be severely handicapped if he had to attempt the control of an insect the origin of which was in a distant province of India.

This subject is fully discussed by Rao Bahadur Y. Ramchandra Rao in his presidential address to the Section on Agricultural Sciences at the thirtieth Indian Science Congress in Calcutta, 1943. It is pointed out in this discourse that an All-India agency is necessary for dealing with pests of this kind, and one of its functions would be to circulate timely warning to those provinces likely to be affected. For the past three years such an agency has been functioning in so far as the desert locust is concerned. The Bombay locust and the migratory locust are of sufficient importance to merit similar centralized methods of attack.

There are also several migratory species of Lepidoptera the larvæ of which entail great damage. Thus the paddy armyworm (*Spodoptera maurita*) appears in huge numbers on young paddy, especially in Malabar, causing enormous damage. It appears so suddenly and disappears so speedily from the scene of its activities that there is scarcely any time for taking remedial measures. In many cases there are definite indications that such infestations had come into existence by the appearance of flights of the parent moths from some distant land, followed by prolific deposition of eggs on the paddy crop. On issuing from the pupæ the resulting moths would appear to have flown to some other area.

In Bihar, the cutworm, *Agrotis ypsilon*, appears in numbers on autumn crops, but is not to be found in the plains between April and August. It is surmised that it migrates to the hills during spring and summer and returns to the plains in the autumn. Similarly, the cabbage white butterfly (*Pieris brassicæ*) breeds on the plains of northern India only in winter and spring, disappearing during April and apparently migrating to the hills for summer breeding.

Examples of this kind where pests are capable of spreading from one province to another require investigation by some central agency that can have access to all affected areas. Mr. Ramchandra Rao discusses the Bombay locust (*Patanga succincta*) in detail and points out that very little is known regarding its habits and phases. The real need at present, he stresses, would appear to be for a system of planning out research on an all-India basis of those problems that cannot obviously be attacked by a provincial agency. In the course of the last two decades various committees have been constituted on such a basis for research on various crops, including some of their insect pests. In this manner a considerable advance of knowledge has resulted in several cases, notably in the investigation of various cane-borers, financed by the Imperial Council of Agricultural Research. What is advocated in this address is the extension of the same principle to those migratory pests already mentioned and to some others of widespread occurrence in India. It is only by some such centralized method of approach that present anomalies are likely to be overcome. As an example it would seem that no organization in particular is responsible for investigating the Bombay locust, which is a pest of all-India importance that is largely neglected. The present time, when swarms of this locust are in abeyance, is opportune to begin such a line of approach by collecting the essential knowledge that alone can place India in a better position to face a new outbreak.

A. D. IMMS.

FORTHCOMING EVENTS

Monday, May 3

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. J. D. Trustram Eve: "Planning of the Countryside".

Tuesday, May 4

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 8 p.m.—Kath Weaver: "New Trends in Soviet Education".

Wednesday, May 5

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. M. Crowther: "Agriculture To-day and To-morrow", 9: "The Maintenance of Soil Fertility".

Thursday, May 6

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. Karl T. Compton: "The Organization of American Scientists for the War" (Pilgrim Trust Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. F. Shipley: "The Protection of Structures against Lightning".

Friday, May 7

ROYAL INSTITUTION, at 5 p.m.—Prof. W. N. Haworth, F.R.S.: "What are Sugars and Starches?"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MINING AND FUELS—The Principal, Huddersfield Technical College, Huddersfield (May 7).

LECTURER (WOMAN) IN GEOGRAPHY in the Brighton Municipal Training College—The Education Officer, 54 Old Steine, Brighton (May 8).

ADVISORY PHYSICIST TO THE RADIOTHERAPEUTIC CENTRE—The Secretary-Superintendent, Addenbrooke's Hospital, Cambridge (May 10).

LECTURER IN MECHANICAL ENGINEERING in the Leeds College of Technology—The Director of Education, Education Department, Leeds 1 (May 10).

SENIOR POST UNDER THE AERONAUTICAL INSPECTION DIRECTORATE (applicants must possess a Degree in Metallurgy or recognized equivalent)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. O.N.F. 1155), Alexandra House, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Part-time Day Education for the Adolescent: Past Experience and Future Developments. A Report of a Conference held at the College of Technology and Arts, Rugby, September 29th, 1942, by the British Association for Commercial and Industrial Education. Pp. 44. (London: British Association for Commercial and Industrial Education.) 1*s*. [223

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TRAINING OF CIVIL SERVANTS

UNIVERSITY OR STAFF COLLEGE?

IN the House of Commons the Chancellor of the Exchequer was recently asked if he had yet appointed a committee to examine the question of the training of Civil servants. The reply was in the affirmative. A committee of nine members has been set up under the chairmanship of the Financial Secretary to the Treasury. Its terms of reference are "to examine the general question of the training of Civil servants, including the question whether a staff college should be established, and, if so, the particular form and character which that college should take".

No one will attempt to deny that the time is opportune for an examination of the general question of the training of Civil servants. Nor, indeed, will anybody attempt to deny that their work and reputation have made them a body of whom this nation can be justly proud. Nevertheless the work of government must be conditioned by the evolution of social and industrial events, and the trend of those events, especially under the impact of scientific discovery, is producing groupings and complexities undreamed of when the lines of Civil Service selection were first determined. It is now very clear that the Civil Service is no longer the preserve of those who have received what is called 'a classical education'. There may once have been an excellent case for an aloof remoteness from the rather sordid details of a busy world as a qualification for government. There also may have been reasons for selecting candidates for government work only from our older universities. But that was before the internal combustion engine and the radio destroyed old boundaries and crushed mankind together on a shrinking planet, thus forcing it to work out new ideas of integration or to perish from stupidity or truculence. Scientific government has become inevitable. It is true that, even before the War, the man of science had entered government service. The Admiralty and the Ministries of Health and Agriculture showed clear enough proof of that. But the process had only just started, and its pace has been immeasurably quickened by war. It must continue to accelerate if the reconstructed world of peace is to come within any distance of the notions men treasure about it.

So, as we have said, the time is opportune for an examination of the general question of the training of Civil servants. We therefore welcome the Chancellor of the Exchequer's announcement, and we have tried to look hopefully at the terms of reference which are to guide the Committee he has set up. At first sight they seem quite innocuous. But, after looking at them a little closely, we begin to wonder at the prominence which is given in those terms to the question of a staff college. They seem to come a little near begging the whole question. There are many ideas which might be included where the general question of training is involved; and it is not unreasonable to ask why the staff college should be mentioned specially. We do not doubt that there may be good and sufficient reasons which so far have escaped us, but we cannot be blamed for recording the impression that the special mention of the staff college may incline the Committee in its favour.

Perhaps, in this connexion, we, too, are not entirely guiltless of having what may be called prejudices. If that be the case, we can at least hope they will be carefully studied by the Committee in order that they may either be finally discarded as prejudices or accepted as ideas not to be ignored if the future Civil Service is to have the proper training for its great task.

Our first point is that a staff college, *if it be the only means of entry into the service*, may do exactly the thing which must be avoided. It will tend to narrow entry and to produce the kind of outlook which has been deplored in connexion with other professions. The gathering together of people intended for a particular vocation must always tend to be unfortunate. Already, in the case of teachers, the weaknesses of training colleges, as they have hitherto been conceived, are standing out clearly under the searchlight of critical examination. The same may be said for students whose training has been secured in a theological college. We believe that professional people gain enormously if, during the period of their qualifying studies, they are able to mix with men and women whose professional aims vary widely. For that reason we hope Civil servants will receive their main training in the universities or in institutions of similar rank where men and women following all kinds of courses may absorb something which is called, vaguely perhaps, general education, as well as studies of more specific and specialized type. Indeed, so far as those branches of the service are concerned which must more and more be staffed by chemists, physicists, biologists and the like, we fail to see how any other course is possible. This same point was emphasized by the Yugoslav Minister of Education at the recent conference of the Association of University Professors and Lecturers of Allied Countries in Great Britain (see NATURE, April 24, p. 466).

There is, perhaps, an even greater danger in the formation of a staff college for Civil servants such as may be under consideration. It is not merely that entrants will miss the wider and healthier contacts with other students. It is also that a staff college may have an unhappy effect on the universities themselves. That danger was brought out by Prof. Paul Vaucher at the above-mentioned conference. "Napoleon had created side by side with the universities," he said, "several professional high schools for the recruiting of his officers and civil servants. They attracted an important part of that *élite* that would have gone to the universities and were indeed so successful that they indirectly affected the methods for training used within the universities themselves. It did not in fact limit or narrow down the extent of learning, but it did in a way reduce the opportunities for disinterested and independent research." This, apparently, was the result of allowing exhaustive competitions to take the part of regular examinations.

Those dangers, it is true, might be avoided, and it is also true that the methods of training in our universities are themselves under close examination because it is said they did not enable the universities to contribute, as they should have contributed, to the swiftly moving and bewildered world of pre-1939. But if university methods are to be changed, it should come from other sources than a staff college set up for special and specific purposes.

We reiterate the point made above. There may have been reasons for giving the question of a staff college the prominence it received in the Committee's terms of reference, but until we know more about them, and until we are assured that the staff college is not to take the place of training already provided in the universities, we cannot help fearing that the very suggestion of a staff college in that context comes perilously near to begging the whole question.

CONSERVATION OF SCIENTIFIC AND TECHNICAL PERIODICALS

THE Association of Special Libraries and Information Bureaux has rendered a real service to scholarship and research by directing attention to the probable post-war demands for sets of scientific and technical periodicals. The pamphlet "Salvage or Storage" which the Association has just issued could scarcely be bettered as a concise statement of the position. Scientific workers are fully aware of the potential demand for complete sets of the publications of learned societies, professional institutions and research organizations, to which the statement confines its attention, to replace those destroyed or damaged in scientific and professional institutions in Great Britain. While, however, the need for restoring the shattered academic life in enemy occupied countries is recognized, the implications of this, in view of the deliberate Nazi campaign against learning, are far from being appreciated.

This demand, as the ASLIB memorandum points out, will be large and very difficult to meet. Not only will files for the war years be very imperfect or missing altogether; in addition, valuable stocks of earlier holdings will have vanished, and restitution, even if possible from Germany, which may be doubtful, is only a partial solution. Great tracts of Europe will require re-educating if we are to hope to exterminate the lust for military domination; and a vital part of this re-education will consist in an ample supply of the literary and scientific output of the free nations. The neutral countries themselves have also suffered inevitable interruptions and losses in the supply of scientific and technical literature originating from both Axis and Allied nations. Even if rehabilitation is restricted to the larger reference libraries, the demand is bound to be great.

The conditions which create this demand, however, at the same time reduce the stocks from which the demand must be met. Under the regulations of the Paper Control in Great Britain, publishing organizations may not use per quarter more than 19·5 per cent of the weight of paper used by them in the corresponding quarter of 1939, subject to special allowances for specific purposes. Not only has this led to reductions in format and in number of pages, but also of the number of copies of each issue. Scientific workers are increasingly aware of the difficulties experienced in obtaining replacement copies of even current issues which may have been lost in the post or in other ways, and there is frequently difficulty in placing a fresh subscription. Especially for technical and scientific works, the home demand has increased, so that, although sometimes offset by the drop in overseas subscriptions, the net result is the reduction of reserve stocks even to vanishing point. When it is realized that losses through enemy action have sometimes been serious and that the drives for salvage have persuaded many private owners to send their copies for re-pulping, the anxiety regarding the future expressed in this pamphlet will readily be understood.

It should be unnecessary to emphasize to scientific workers the primary importance to the research worker and scholar of complete sets of all periodicals issued by learned societies, etc., being available in a reasonable number of the larger reference libraries. It is impossible to distinguish one set of publications as being of permanent value while another can be safely discarded. The publications of certain relatively obscure local organizations have on more than one occasion proved of value in the war effort.

Storage and dispersal problems alone would preclude the issue of a national appeal for the preservation of all holdings of periodicals issued by learned societies, research organizations, etc. A central depository is obviously undesirable, and the Central Committee for the Recovery of Books and Manuscripts of ASLIB is working upon the principle of dispersal in regard to books, but for periodicals a strong central organization and efficient records are almost impracticable under war conditions. To meet this difficulty the ASLIB memorandum suggests that learned societies, professional institutions and research organizations which do not possess good reserve stocks, or which cannot disperse these to safeguard them against enemy action, should ask all their members to retain their own copies, in order that those not wanted for permanent filing may be called in after the War to complete the stocks of British and foreign libraries.

It should not be difficult for societies to keep a card index of subscribers who undertake to co-operate in this way, so that future stocks can be roughly assessed. Where subscribers cannot for various reasons retain the periodicals in their own custody, it is suggested that they should notify the following, in the order named, and offer these organizations the opportunity of storing the periodicals against future needs: the publishing organization; the local public or county library; the Science Library; the Library Association; the National Central Library; or ASLIB. Unless the periodical is very rare, damaged or dirty copies should be sent for salvage. These suggestions relate to British publications. The war-time issues of foreign publications of learned societies should only be discarded after expert advice. The memorandum should be sure of a ready response from all scientific workers, who may well be grateful for a timely and lucid statement on the situation.

EDUCATIONAL PRINCIPLES

Education for a World Adrift

By Sir Richard Livingstone. (Current Problems, No. 17.) Pp. xvi+158. (Cambridge: At the University Press, 1943.) 3*s.* 6*d.* net.

THE educational storms that have raged over Great Britain during the last generation or so have usually been connected with the machinery of education. There have been few who have been content and far-seeing enough to sit back and look steadily at the whole canvas of education and to contemplate its objectives. For this there are several reasons. Not many people are prepared to set out clearly defined aims in education, while those that do often present such a narrow outlook that their argument frequently returns to problems of machinery. Fortunately, with a new Education Bill in the offing, there are indications that educationists are becoming disturbed more by shortcomings in the fundamentals of education than by the mechanics of administration. Adequate, smooth-running machinery is necessary to make the products we need and seek. Much more important is it to know what kind of product we wish to make. There is little use in transforming immature beings into mature members of civilized society unless we ourselves are clear what we mean by maturity and civilization.

Credit, therefore, must be given to Sir Richard Livingstone for his courage in facing up to the real issues of education and for his resolve at this stage in refusing to be drawn into discussions about the operation of the various processes in education. Buildings, playing-fields, school meals, nursery schools, etc., are all of greatest importance. But these are incidentals and not so important as what is being taught and what we wish to procure inside the schools.

Three things, says Livingstone, are essential. The knowledge necessary to living must be imparted. People must be taught to use their brains. Most important of all, people must have placed before them a clear set of standards and values and must be prepared to live by them. It is mainly with this problem that his book deals.

In an analysis of the present age, the author states his beliefs as follows. This, he declares, might be called the Age of Science, or the Age of Social Revolution, or the Age without Standards. He is concerned with it in the latter aspect. "The nineteenth century had a soul, a spirit; what soul, what spirit, has ours? The child of the Victorian age was born into a world of stable traditions and clear standards and was shaped from birth in their strong moulds. The child of to-day is born into a world whose traditions and standards are weakened, a world with inherited good habits, but no ruling philosophy of life.".

The philosophy of the nineteenth century, according to Livingstone, was based on Christianity, reinforced, "to a far greater degree than is generally realized, by the clear and noble ideals of Hellenism, through the classical education received by the governing classes. It would be difficult to find any leaders of the age whose outlook on life was uninfluenced, if not formed, by one of these." In discussing the apparent absence of a purposive philosophy in our time, the author suggests that only by a return to the Christian and Hellenistic philosophies will this and future generations be able to produce men and women capable of living a fuller and richer life. That, in essence, is the theme of this book.

As a means of regaining these lost spiritual values, Sir Richard reiterates some points which he has discussed in an earlier work, "The Future in Education". To counteract the spiritual flatness and lack of values in young lives we should ensure that visions of greatness in human life and character be set before them. This can be done by teaching literature and history, the Bible and the Greek classics (in translation) being chiefly used as source-books. So that young people shall not be influenced by stories of cruelty and treachery and wickedness, it is important that their reading-matter be carefully chosen and that the "first-rate" is set before them as worthy of emulation. Unfortunately, even a casual reading of Sir Richard's prescription of set books and authors reveals a tragic lack of acquaintance with the common people for whom the medicine is being prepared. The suggestions might profitably be used for the very small section of the population who are attracted towards the "cultural", but would contribute little to the life of the majority. This unawareness of the people is paralleled by some peculiar misinformation which is supplied about the parade ground. "Mere character training in the narrow sense could be carried out by a drill-sergeant; courage, endurance, fair-play, discipline, could be learnt on a parade ground and the work would need a far less highly qualified staff than those of a school."

The intrinsic weakness of this and other books on education by the same author are bound up with this point. His philosophy offers a great deal to those who are wont to look at truth from the angle of the humanities and the heights of classic aloofness. In bridging the gap—artificial but very real—between the cultural and the vocational, the abstract and the practical, it does little except, perhaps, widen the cleavage.

This can readily be seen in Livingstone's attitude to science. No frontal attack is made on science, yet it would be difficult to find another work in which science is so magnanimously disparaged, and so "back-handedly" praised. "During the last war the salvation of the world was assigned to science. Now we are disillusioned. Science, like medicine, is an integral part of civilized life. It is difficult for human beings to maintain health without doctors but medicine is not health. It is difficult for a civilization to be sound without science, but science is not civilization, and few people can suppose that salvation is its business." Scientific men, the author goes on to say, frequently go beyond the limits of their subject; science is non-moral and unconnected with standards of value. The man of science might well retaliate that his governing principle—the search for objective truth—is in itself a moral principle which must be honoured in the observance and not the breach. The difficulty seems to be in Livingstone's assumption of an absolute scale of values. Science would argue that moral and ethical and spiritual values are by no means the same at different times and at different levels of civilization. Scientific discoveries have often been responsible for overthrowing outworn principles which have been established and sustained by inadequate knowledge. The treatment of criminals, prisoners, paupers, the insane, mentally defectives and the under-nourished has been considerably modified by scientific investigations, while we are all familiar with instances of how religious outlook has been modified by changes which in origin were quite unrelated to religion.

Reverting to Sir Richard's main premise. Is he right in saying this is an "Age without Standards"? Is the nation which rose to arms in 1939 in defence of the "Four Freedoms", which includes freedom of worship, devoid of spiritual values? Because those outward forms of religion which met the spiritual needs of some Victorians are disappearing, is it just to assume that the spiritual quality of our people has been lowered? And is it too much to hope that men of liberal education may yet realize that the last hundred years has produced a challenge to traditional and dogmatic habits of thought that cannot be brushed aside? Instead of readily assimilable and comforting beliefs in design and purpose, men and women are seeking truth—absolute truth—even if it brings the house of dogma crashing about their ears.

A serious criticism of the structure of this book is the misuse of quotations. In an essay of this nature, the argument can often be driven home more surely by quoting an extract from another writer. In many cases here the argument becomes little more than a method of linking up quotations. These are almost entirely lengthy excerpts from the classics and are not always apposite. T. H. HAWKINS.

POPULATION OF BRISTOL

The Population of Bristol

By H. A. Shannon and E. Grebenik. (National Institute of Economic and Social Research, Occasional Papers 2.) Pp. 92. (Cambridge: At the University Press, 1943.) 7*s*. 6*d*. net.

THIS is the second of the 'occasional' papers issued under the auspices of the National Institute of Economic and Social Research. It includes an introduction by Prof. Hamilton Whyte, a section by Mr. H. A. Shannon dealing mainly with migration into and out of Bristol, and a reprint of the important paper contributed by Mr. E. Grebenik to the *Journal of the Royal Statistical Society* in 1940 on "Some Aspects of Population in Bristol", which the author himself in a final short chapter puts into less technical language.

In the last analysis the people constitute the real wealth of any country: they are the prime agents in making all material wealth effective by turning raw materials into riches. It follows that studies of trends in the quantity and character of the population are extraordinarily valuable. This particular study has additional interest because few attempts have been made to discuss in such detail the population of a comparatively small and compact area. The only criticism one might offer relates to the price of the publication, if it is to be widely read. It is high, in view of the fact that the pamphlet contains only 57 pages of new matter; and of the total no fewer than 24 pages are taken up with tables, concerning the employment and origin of migrants, which in these days of paper shortage could with a little ingenuity have been advantageously compressed.

Mr. Shannon's contribution starts with a survey of the population changes from the beginning of the nineteenth century. Those who live in great cities get the impression that England is sadly overcrowded. Such impressions are corrected on reading "the city [that is, Bristol] . . . is seen greatly to have outstripped its surrounding county fringe [namely, Gloucester and Somerset less Bristol] from at least 1821. . . . It is barely an exaggeration to say that that county fringe has remained stationary for the last hundred years." The truth is that people in general prefer company—or the amenities which living in the neighbourhood of large groups brings—to solitude.

Bristol, as defined by its 1935 boundaries, registered in the seventy years 1861–1931 a total increase of some 225,000. Of this total, the *net* increase due to migration is estimated to have been trifling, of the order of 2,000 only. The growth of population was due almost entirely "to the fertility and natural increase of Bristolians". While the net gain by migration to the city, as a whole, has been slight, there has been—as in most other large centres of population—a steady stream of migrants from the inner to the outer areas of the city, fostered by slum clearance and the development of new housing estates nearer the open country.

The effect of re-armament on the figures is clear: the wider fringe of Bristol, in the region of the Filton aircraft works, which before had been substantially rural in character, showed a jump in the electoral roll from round about 20,000 in 1931 to nearly 30,000 by 1938. In fact, if for this purpose an immigrant is defined as a person who holds an insurance book issued outside Bristol, the figures show that 30 per cent of the adult male immigrants into the borough have entered the aircraft industry, which is now the city's leading industry. This, with building and the distributive trades, accounted for more than one half the adult male immigrants. Distribution, hotel and club service, and food manufacture accounted for two out of every three women immigrants. Such concentration of both male and female labour, in view of the large assortment of trades which Bristol offers, does not presage well for the future when peace returns. It is in large part due to war conditions, and it can no doubt be multiplied many times if other parts of the country are considered. The problem is clearly one that needs to be attacked on a national scale.

In keeping with the results of similar investigations elsewhere, the majority of the migrants come from nearby areas, but the tentative suggestion is made that this seems to be less true of skilled than of unskilled immigrants. Another point of interest is that the immigrants generally experience a higher degree of unemployment when comparison is made with the native stock. Moreover, this difference is consistent: it holds for both males and females, and for each age-group tested.

Mr. Grebenik has summarized the results of his researches lucidly and concisely, and some of his conclusions are worth recording. Neglecting migration, and assuming the fertility- and mortality-rates of 1937 to remain constant, he estimates that in 65 years time Bristol will have only about 273,000 inhabitants as compared with 415,000 at present. The number of children under fifteen years of age will then actually be less than the number of old people. They will account for not more than 15 per cent of the population, while old people of 65 years and more will account for 20 per cent. This will mean a diminished demand for schools and teachers, maternity and child welfare clinics, but greater pressure on social services catering for the aged.

Among the most striking figures quoted are those showing the average age of mothers in different occupational groups at the birth of their first babies. It was found to be 28·0 years in the middle class, 26·2 among skilled artisans, and 24·5 among unskilled workers. Again, the proportion of children of high parity orders (that is, the proportion of seventh, eighth, ninth . . . children) discovered among the middle class was only 1·2 per cent; among skilled artisans it was 2·1 per cent; while among unskilled workers it rose to 13·8 per cent. On the other hand, the proportion of first children born was 52·1 per cent among the middle class, 47·2 among skilled artisans, and 25·0 among the unskilled.

Such records as these, throwing light on both the general decline in fertility and its differential incidence, should open the eyes of all who read to the nature and gravity of the population problem, and to its reactions on trade and employment, the social services, the provision of necessaries and amenities, and indeed every aspect of the life of the community.

D. Caradog Jones.

ARCHÆOLOGY AND MODERN MAN

What Happened in History

By Prof. V. Gordon Childe. (Pelican Books. A. 108.) Pp. 256. (Harmondsworth and New York: Penguin Books, Ltd., 1942.) 9*d*.

PROF. V. GORDON CHILDE is one of the foremost prehistorians. He has travelled widely and done much work of great importance to the specialist; he has, as it were, personally added many bricks to the edifice of prehistoric knowledge. But he has also long realized that prehistory and early history form a continuum, and that, by standing back and contemplating the whole, many general conclusions can be arrived at with regard to the rise and fall of civilizations. Too often volumes purporting to give such cultural résumés come unavoidably from the pens of 'scissors and paste' authors who do very good work but cannot, of course, write with any personal authority.

For this reason a special welcome must be accorded to Prof. Childe's fascinating little book now under review. In it he discusses the changes in material well-being and mental outlook that have taken place throughout the ages up to the break-up of the Roman Empire. He gives us a brief survey of what he describes as Palæolithic and Mesolithic savagery, of Neolithic barbarism, of the rise of the Metal Age cultures and so on until a climax was reached as a result of the Old World unity made possible by the exploits of Alexander the Great. Finally, there is a stimulating chapter with the author's views about the decline and fall of the ancient world. At this point one naturally recalls T. R. Glover's treatment of the subject in his "The Ancient World", but the present work, of course, deals with an infinitely longer time-span of human effort.

Naturally, Prof. Childe has had to select and compress his background material to a cruelly hampering degree, and has consequently had to make a certain number of dogmatic statements, some of which may perhaps be open to challenge in detail by other specialists; but this is inevitable. Again, in the nature of the case he has had, as it were, to view humanity as one whole, advancing or retreating along the same road, even if not always at the same time. Perhaps not quite for the same reason, the external causes for changes in human ways of life and outlook —climatic changes and the like—are not much discussed: man makes himself is the creed adopted. But the conclusion that history is two-dimensional, or as Prof. Childe says on the last page "the upward curve resolves itself into a series of troughs and crests", with each crest reaching to a new high level and no trough as deep as the one before, is one that is not always sufficiently appreciated nowadays. Personally I have long believed that this is one of the fundamental lessons that can be derived from the general study of human progress: history may indeed repeat itself, but the repetition is not merely circular; it is spiral. It is indeed three-dimensional.

In a general connexion, on p. 21, the author throws out a suggestion that "cultures are tending to merge into culture", which will perhaps fill some people with foreboding—the cultural temperature resulting from such a merger would probably be a tepidity of the Laodicean kind! On the other hand, of course, the "limitless multitude of Neolithic cultures" referred to on p. 56 must have constituted an equally unsatisfactory background for human advancement. Nevertheless, it has always seemed to me that this was a tremendously important moment in cultural evolution: that the discoveries which led to the rise of the Neolithic civilization were perhaps the most fundamentally important ones ever made by humanity. Community life as we know it, with all the social and moral problems it involves of the regulation of human behaviour, dates from the discoveries of agriculture and the domestication of animals.

Very interesting indeed to us to-day is Prof. Childe's implication in his last chapter that the later Roman emperors introduced Nazism in an effort to escape the oncoming decline and death of civilization. It is perhaps not *quite* so satisfactorily explained exactly why the ancient world was dying, unless we accept the natural idea of old age. Civilizations are not unlike individuals. They are born as a result of culture contacts and, unless killed, survive for a span before disappearing. But, as the author's optimistic creed indicates, they do hand on a something which is taken over by their successors—the next great civilization to arise.

This more than worth-while book contains many facts—the background material for the study; but it is primarily intended to stimulate thought and to help the reader to understand the general story of human development and, may be, to draw lessons which will help when our own civilization, now in danger of collapse, is once again in process of reconstruction.

M. C. BURKITT.

THE STORY OF MAGNITOGORSK

Behind the Urals

An American Worker in Russia's City of Steel. By John Scott. Pp. 224. (London: Martin Secker and Warburg, Ltd., 1942.) 7*s*. 6*d*. net.

THE cause of world freedom owes much to the amazing development of mineral resources and heavy industries in the Soviet Union since the inception of the first Five-Year Plan. In the late 'twenties, thanks to the sagacity and foresight of their leaders, the Russians embarked on a vast scheme of industrialization in the Urals and Western Siberia, far distant from the nearest frontiers, in the face of appalling difficulties. Since the old industrial centre of the Ukraine has been overrun, these newly developed regions have indeed become a stronghold of Russia's unconquerable resistance.

For more than five years John Scott, an adventurous young American engineer, shared the life of the Russian workers while helping to build blast furnaces and operate the coke and chemical plants of Magnitogorsk, on the eastern slopes of the Ural Mountains. His remarkable story, written with stark realism, tells of the triumphs and privations of those who struggled to change Magnitogorsk from a squalid village of Kirghiz and Bashkir herders into one of the world's largest metallurgical plants, with a production of about 3 million tons of steel a year. Even more impressive than the documented statistics which bespeak the progress of material achievements is the illuminating account of daily life in Magnitogorsk, of the patriotic enthusiasm, the intense striving after education, the confusion and disorders, the unquestioning obedience to the dicta of the Communist Party, and of the purge which struck the city in 1937.

The author is neither a dilettante nor a partisan propagandist; he actually dwelt and toiled as a Russian, and although his writing is imbued with the spirit and atmosphere of the Revolution, it is none the less a sane and balanced study of the benefits and shortcomings of socialism as it recently functioned in Magnitogorsk.

If this extraordinary book attains the wide circulation it deserves, it should help to promote better Anglo-Russian understanding. Especially should it be read by those who have not ceased to wonder how the peoples of the Soviet Union have so successfully withstood the armed might of Nazi Germany.

DAVID WILLIAMS.

ORGANIC REACTIONS IN LIQUID SYSTEMS

Mechanism and Chemical Kinetics of Organic Reactions in Liquid Systems

A General Discussion held by the Faraday Society, September 1941. Pp. ii+601–806. (London and Edinburgh: Gurney and Jackson, 1942.) 15*s*. net.

THIS volume contains fourteen papers on various aspects of the mechanism and kinetics of organic reactions in liquid systems, together with reports of discussions on them at a meeting of the Faraday Society in September 1941 (see NATURE, Jan. 31, 1941, p. 126). The topics included various kinds of substitution reactions, elimination reactions, hydrolysis, addition and condensation, prototropic changes, anionotropic changes, substitution reactions, free radicals, Cannizzaro reaction, and ring closure. A wide and important field was thus covered.

The main emphasis was laid on the electronic theory and modern interpretation of the processes discussed, and as the papers are in the nature of monographs by leading workers in the fields, and have full bibliographies, the interesting and valuable character of the book will be appreciated. Modern organic chemistry is making full use of recent advances in physical chemistry, and in the theory of atomic structure and bond formation which has been worked out in theoretical physics. Some idea of the great advances in the understanding of organic reactions which this new knowledge has made possible can be gathered from the work reported here, and both chemists and physicists should find the volume both stimulating and useful.

The Faraday Society General Discussions are well known and appreciated as valuable contributions to the advancement of knowledge, and the present volume well maintains the high standard set in previous General Discussions.

NEWS AND VIEWS FROM THE SCIENTIFIC FRONT*

By SIR RICHARD GREGORY, BART., F.R.S.

IN the middle of last century, contemporary thought was no more ready to receive, or able to understand, Darwin's scientific evidence as to man's place in Nature than philosophers and theologians of Galileo's time were willing to be convinced of the truth of his observations and the rational conclusions derived from them. When the "Origin of Species" was published the review copy sent to *The Times* was handed to a member of the staff who was responsible for notices of literary works generally. He was an excellent journalist but as innocent of science as a child, so he exercised editorial functions and asked a friend to suggest someone who could write a review which he could adopt with a few introductory remarks of his own. Fortunately, T. H. Huxley undertook to do this, and his fine article on Darwin's book appeared in *The Times* unsigned in the usual way. It was not until later that he permitted it to be known that he was the author of the review.

At that time the *Saturday Review* devoted a fortnightly column to scientific subjects, and this led Huxley to believe that a quarterly magazine surveying advances of science in a systematic way was wanted, particularly on account of the poor state of natural history journalism. He therefore became chiefly responsible for the launching of the *Natural History Review* in January 1861 and continued as its overworked and unpaid editor for two years. He then ceased to contribute to the magazine, but the publisher, Mr. John Murray, decided to carry on with paid contributors and editors instead of volunteers. As, however, the enterprise was never sound financially, there was little hope for it under the new scheme and the magazine came to an end in 1865.

The promise of success of a quarterly review for general scientific readers, whether devoted to the biological or the physical sciences or to both, is no better to-day than it was then. Most scientific and technical societies provide facilities for keeping their members in touch with advances in their own professional spheres, but their vocabularies are usually so highly specialized that they are unintelligible without preliminary acquaintance with their meaning. After the *Natural History Review* had failed to find a sufficient circulation to maintain its publication in quarterly issues, a weekly periodical of a less specialized kind, *The Reader*, was started and Huxley took an active part in conducting it, until it also came to an end after a life of three or four years only.

J. Norman Lockyer, who was the science editor of *The Reader* during its existence, as well as a contributor to the *Saturday Review* and other nonprofessional periodicals, was led by his experience to the conclusion that a weekly journal of science of a more comprehensive scope than any previously published was needed by both scientific and general readers. He was at that time scientific adviser to the Macmillan firm of publishers, and the head of it, Mr. Alexander Macmillan, believing that the interests of science and of the British people would be advanced by such a journal, warmly supported plans for its establishment. All the leading contemporary men of science promised active co-operation in Lockyer's scheme, the result being that the first number of NATURE appeared on November 4, 1869, with Messrs. Macmillan as the publishers [see also NATURE of February 27, p. 231].

In that period public attention was being directed to scientific subjects in the general Press and other periodicals. A weekly *International Review of Scientific Lectures*, published in Paris, was devoted to public lectures delivered by leading scientific authorities in the chief countries of the world, thus enabling general readers, as well as men of science, to become acquainted with the advances being made. A few weeks before NATURE was published, Mr. John Murray began the issue of the *Academy*, "a monthly record of literature, learning, science and art". Prof. Huxley and Sir John Lubbock were among the scientific contributors to the first number. Though the *Academy* gave particular prominence to scientific subjects, and included in its second number several papers by Helmholtz, Mayer, Virchow and other men of science read at a meeting of the German Association of Naturalists at Innsbruck, as well as summaries of other communications, it did not become a rival to NATURE, as was feared it might do, and friendly relations were always maintained between the two editors.

What Lockyer desired to do was to promote public interest in science and its achievements, whether through the general Press, lectures, or in any other useful way. The more contacts he could find between science and the public mind, the better he was pleased. With Huxley and Tyndall he combined scientific authority with literary power, and represented, therefore, the most effective type of connecting link between science and the citizen, whether through articles or in popular lectures. It was to assert the rights of science to an honoured place in national service, as well as its responsibilities to the development of natural resources, both intellectual and material, that NATURE was founded.

The establishment of a weekly periodical to promote public understanding of science, and at the same time to provide a forum for natural philosophers, was a notable event in the history of journalism. It is true that, nearly forty years earlier, the British Association was founded with much the same intentions, but as it met in full session only once annually, accounts of its activities in the periodical Press were limited to a few issues.

The attitude of the public Press, when the founders of the Association charged themselves with the obligations "to obtain more general attention for the objects of Science" and held annual meetings in different parts of the country for this purpose as well as for the discussion of scientific advances, was the reverse of encouraging. It was represented in contemporary journalism by Dickens' articles in *Bentley's Miscellany*, afterwards published as the "Mudfog Papers". These contributions were caricatures of the proceedings of the first and second meetings of the Association and of the men of science who took part in them. Less crude, but just as derisive, views as to the meaning of science and its service to the community prevailed in literary circles generally. *The Times* ridiculed the Association and its objects at the beginning and continued to do so for a number of years afterwards. It and other journals of the time, like *The Age* and *John Bull*, regarded the entrance of science into public life as an intrusion, and its efforts to extend the understanding of it as evidence of a desire for self-advertisement.

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* Substance of an address at the Conference on Science and the Citizen held under the auspices of the British Association Division for the Social and International Relations of Science in London on March 20–21.

By the middle of the century, however, contempt had changed to condescension, and the public mind was ready to give sympathetic consideration to the utterances and publications of what had been described as a "hodge-podge of philosophers" by such a cultured representative of higher learning as John Keble of Oxford. Even though the tone of literary scholars and leaders of the Press towards scientific work and thought continued to be supercilious, the new humanism made a strong appeal to many progressive minds; and leading organs of the Press introduced its chords into their harmony of news.

When NATURE made its first appearance, the period of opposition to organized science and its public relationships had been left behind. From being regarded as presumptively vociferous, the natural sciences came into positions of authority among the progressive elements of human thought and action. The Great Exhibition of 1851 and the second International Exhibition held eleven years later had given new outlooks to industrial science and its profitable development. Labour asserted its rights to a place in the economic field by the formation in 1864 of the International Working Men's Association, which afterwards became "The International". To guardians of traditional learning and social privileges, both science and labour represented revolutionary movements which had to be admitted into the fields of public affairs even though their motives and purposes did not approach the conventional standards of Victorian respectability. The common cause was to secure freedom of thought and action and the advancement of human welfare.

The periodical Press took critical or helpful attitudes towards these claims, each reflecting the views of most of its readers and some using a lens instead of a mirror to examine them. In order to exist, a journal, like a human being, must have a good circulation as well as a heart to keep the living stream in full flow. In journalism many hopeful hearts have believed that a large body of the public was waiting to respond to their strong and steady throbbing, but have been doomed to disappointment. Sooner or later, the public, general or special, gets the kind of journal it wants, and decides whether or no its publication is worth while financially. From a business point of view, lack of sufficient support is more often due to being in advance of the times than lagging behind them.

In the 'sixties of last century scientific forces formed the spearhead of cultural movement; but though their main advances compelled attention they broke up an established system of defence and received, therefore, little support from other elements in the front line. In the absence of accurate and intelligible accounts of operations in scientific fields, neither the public nor its leaders could arrive at a right understanding of their meaning or justly judge the value of the resources of the new territory of natural knowledge. There was need for the organization of scientific intelligence and also for the expression of scientific opinion upon educational and other public problems then under discussion. The time had come for performance to be related to progressive policy and science to exert its influence in the realm of the Fourth Estate. It was with the object of presenting news of advances in the expanding field of natural knowledge and of expressing the views of leaders in the scientific services on contacts of such knowledge with current questions in which it was an important factor, that NATURE was founded.

The entrance of scientific 'usurpers' into the fields of public policy and established learning met with a hostile reception, but it was welcomed by enlightened leaders in other cultural groups. The moment was opportune to make their advances and influence known to all who cared to give attention to them, even though the promise of support was relatively small. Confidence in a cause has to be sustained if success is to be achieved, and it was needed to found and maintain a weekly scientific journal in the third quarter of the nineteenth century, when education in science had a very minor place in the schools. At that time interest as well as enterprise were required to establish a periodical of this kind. Fortunately, Mr. Alexander Macmillan, who was then the head of the great house of publishers bearing his name, possessed these qualities and maintained his faith in the mission of science without consideration of financial profits to be derived from the publication of its weekly message. It was not until towards the end of his life in 1896 that NATURE became self-supporting, though from the beginning the journal was esteemed as the accredited organ of scientific fact and opinion.

One of the reasons for the long-delayed fulfilment of early promise was the increase of specialization among scientific workers. In the quarter of a century following 1869, nearly fifty separate societies were founded, each dealing with a particular department of science or technology, all of them issuing publications of a special kind, and some having their own journals. It became difficult to keep in close contact with developments in even a single field of operations, and more so for workers in other fields to understand the terms in which advances were described. The forces in the front line lost touch with one another, but each continually entered new territory and established strong positions in it. The common purpose of the pioneer corps was to clear away the tangled growth which obscured most of the features of Nature and to explore what was beneath it. The object of the technical services which occupied the territories acquired was to examine the resources in them and apply discoveries to useful ends.

Among the journals in existence before NATURE made its first appearance were the *Lancet*, *British Medical Journal*, *Chemist and Druggist*, *Electrician*, *Engineer*, *Engineering*, *Gardeners' Chronicle*, *English Mechanics* (now *Mechanics*), and *Pharmaceutical Journal*. A journal which aimed at recording notable movements along the whole line of advance of pure and applied science in terms intelligible to all of them as well as to non-professional readers with wide interests had to undertake the duties of an intelligence department with the policy of a general staff.

For more than fifty years, the general staff responsible for the conduct and contents of NATURE consisted of two officers—an editor and an assistant editor. Correspondents from all parts of the world made the journal a centre of scientific news and views from the very beginning of its foundation. The increase in numbers of scientific and industrial research centres led to a greatly increased volume of original communications from them. The result was that NATURE became a kind of clearing-house at which scientific drafts were presented and their exchange values adjusted. In a single year before the present War, nearly one thousand letters from original investigators appeared in the correspondence columns of the journal. One sixth of these letters were from scientific centres outside the British Isles, and thirty different countries were represented by their writers. The journal thus came to be recognized as a world medium in which early announcements could be made of new scientific observations and conclusions.

By providing the means of expansion of old industries and creating new, science has transformed conditions of civilized life and influenced the whole social structure. In Darwin's days beams from strong scientific searchlights revealed weak parts of ancient bulwarks which were believed to be impregnable. The beams came from a lighthouse and were not produced for purposes of aggressive action by new forces but for the guidance of mariners in mysterious seas. They were, however, so dazzling in their effects that they were resented as a danger to established principles of navigation instead of being welcomed. The conflict which then arose was between champions of new and old ways of looking upon human life in its philosophic and spiritual aspects. Later, the cry of danger was again raised against science because poison gases, high explosives and bombs from aeroplanes were among its fruits. The War of 1914–18 brought this attitude towards science into prominence, and the view was expressed by responsible leaders of thought that a halt should be called to further advance of knowledge because of the dehumanizing results which might be derived from them. By this time, however, there was a sufficient body of responsible opinion to assert the right of science not only to liberty of thought and action in its own fields, but also to be a component part of the executive staffs in control of the disposition of its forces.

The campaign with these objects in view as well as to establish closer contacts between science and other formative elements in the social structure was opened in NATURE of October 21, 1915, with a leading article on "Science in National Affairs". Every week since then the journal has had the temerity to express opinions upon current affairs in which scientific methods and services are involved. Without entering the field of party politics there has never been a lack of important public problems requiring scientific knowledge as well as wisdom for their right solution.

The result of the revival of the scientific movement has been to give the social and international relations of science both shape and policy. In 1938, the British Association established an autonomous Division of its constitution to promote these objects, which were among its original purposes. There are still many people who regard men of science as members of a kind of monastic order content to carry on their studies in cloistered seclusion, whether their lives and work are of service to others or not. The history of science is rich in examples of men of this type, pursuing knowledge for its own sake without thought of recognition in this world or reward in another. They are the saints of science and are revered as such by all who esteem truth and the high endeavour its pursuit entails. To these natural philosophers, the impressive fabric of science owes the main features of its design and execution; and no tribute is too great to be paid to them.

Science is, however, a gospel of righteous principles however much they may be departed from in practice. It has the duty not only of preparing messages but also the mission of interpreting their meaning to all who will give attention to them. In the history of civilization there has never been an epoch in which understanding of the spirit and service of science was more necessary for the public and its leaders than now. A century ago wide public interest was aroused in scientific subjects through descriptive lectures with experimental and other illustrations, but there is far less demand in these days for the expositions which were then so popular. The cinema and broadcasting can now perform this informative function much more effectively than peripatetic lecturers. What the public is ready to take active interest in to-day is the impact of science upon social conditions, and its relations to life and labour. These are subjects upon which any individual citizen affected by them can have his own opinion and is at liberty to express it. The function of science at a public conference or meeting is to present the results of impartial inquiry into any such subject for which a meeting is convened and to provide whatever further information is available relating to it.

The British Association, through its Division for the Social and International Relations of Science, could most appropriately organize such public conferences at suitable centres anywhere in Great Britain, and by doing so would greatly assist in the extension of knowledge of contacts between the natural and the social sciences. It could do at home what the British Council is doing for science and other fields of culture abroad, but to undertake such an educational enterprise successfully would require much greater financial support than the Association is at present able to provide. If this Conference on "Science and the Citizen" should lead to the establishment of a kind of public university extension movement, with particular reference to science and social values, it would mark the beginning of a new era of constructive co-ordination of progressive scientific knowledge with changing social needs.

THE CONCEPT OF ENERGY

By DR. A. E. BELL

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IN an earlier article entitled "Modern Science and Thomas Hobbes"[1], I remarked that it was especially the law of conservation of energy which inclined thinkers of the nineteenth century to a rigid determinism. The concept of energy gained such great prestige during the latter half of that century that it seemed as if physics were as much preoccupied with energy as the chemists were with matter. Although that era is gone and the historian of the relativity theory will have to show how the two fields became less completely demarcated, the old categories of thought still remain, and for many purposes perhaps they always will. In any event the concept of energy in classical physics holds much the same central position that the atomic theory holds in chemistry—but there are no comparable historical studies.

One hundred years ago, Sir William Robert Grove gave a course of lectures at the London Institution, later published (in 1846) under the title "On the Correlation of Physical Forces". In these lectures Grove pointed, for the first time, to the interconversion of various physical 'forces' and argued the existence of some underlying identity; in essence he gave a formulation of the general law of conservation of energy. The full importance of Joule's paper of

1843 was understood by Grove, for it is clear that he was exploring the same problem. But even if it is true that, as F. W. Hobson remarked, "the notion of Matter is one formed by common sense, but the conception of energy has been created by Science for its own special purposes", it would be wrong to suppose that the concept sprang suddenly into use in the nineteenth century. Writing of physical science in 1838, Osborne Reynolds said: "The terms 'energy' and 'work' did not exist in the language of science in their present significance"; on the contrary, although the product mv^2 was accepted as a mechanical quantity, the idea of work or motion against resistance "expressed as a product of the distance, multiplied by the mean resistance overcome, although it was known to express the half of the change in the vis viva which takes place in a body moving against resistance, had never been recognized in the schools of mechanical philosophy as a fundamental measure of mechanical action, either as 'work' or by any other name"[2]. Nevertheless, the importance of measuring motion against resistance was increasingly recognized by engineers, who were applying the steam engine to more and more industrial uses. So early as 1759, Smeaton, in a paper published by the Royal Society, compared the relative powers of undershot and overshot water wheels—the application of kinetic as against potential energy—but the steam engine was the chief source of quantitative investigations. With the development of machinery it became an urgent matter to have some method of specifying the power required. Watt settled the unit of power to be employed, but the great question of how much power might be obtained, theoretically, from the steam engine was first successfully tackled by Sadi Carnot. In 1824 he wrote: "Everywhere where there is a difference of temperature, everywhere where there can be a restoration of equilibrium, there can also be a production of motive power. . . . Conversely, everywhere where this power can be consumed, it is possible to produce a difference of temperature. . . ." From a theoretical calculation of the ratio of the specific heats of air he went on to obtain a value for the mechanical equivalent of heat. That this was erroneous matters less than the important advance begun by Carnot, for he had grasped the important truth known as the First Law of Thermodynamics, and this law in the form $dQ = dU + dW$ is only a special case of the law of conservation of energy.

Joule also, of course, had the outlook of the engineer rather than that of the theoretical physicist. Before him Julius Mayer, following a line of thought started by Gay Lussac and Séguin as well as Carnot, had speculated on some form of conservation hypothesis; but as Joule himself remarked, there were no such proofs "as were sufficient to cause it to be admitted into Science without further enquiry". These proofs his own painstaking experiments amply supplied. Even if he had "nothing but hundredths of a degree" with which to prove his case, Joule convinced even if he did not rouse the scientific world. Kelvin and Helmholtz between them, in the years immediately following 1847, explored the theoretical problems connected with the law of conservation of energy, and Rankine, Clausius and Kelvin developed the dynamical theory of heat. Thomas Young introduced the term 'energy' so early as 1801, pointing out with respect to the product mv^2 that "many of the sensible effects of motion, and even the advantage of any mechanical power, however it may be employed, are usually proportional to this product". Rankine introduced the term 'potential energy' and Coriolis (1844) and Poncelet (1874) both made use of the term 'work'.

Looking back over this period, one is struck with the attempts of many physicists to get at the physical nature of energy, much as the chemists sought to discover some ultimate key to the nature of matter. To these the quantitative relationships appeared inadequate. But it had to be admitted, as Fleming then wrote, that "We have no experience of Energy apart from Matter of some kind, nor of Matter altogether devoid of Energy . . . The moment . . . that we pass beyond these merely quantitative ideas and proceed to ask further questions about the nature of Energy and Matter we find ourselves in the presence of inscrutable mysteries . . ." These physicists forgot that the concept of energy arose from preoccupation with the idea that there are permanent elements in Nature; its formulation was from the first mathematical and rested on the study of isolated systems.

Energy is essentially a European concept. So far as one can tell, the Greeks came no nearer to it than to recognize some sort of resistance to motion that had to be overcome. Aristotle's influence was behind a purposive or teleological view of Nature which depicted events as drawn towards their ends. There have been recrudescences of the teleological view ever since the seventeenth century, when it seemed to have been finally banished, but in mechanics the only noteworthy example is Maupertuis's formulation of the Law of Least Action. It proved difficult to find a method of expressing the determinism of events, however, and Jordanus and da Vinci, for example, early students of mechanics, had only hazy ideas of force and perhaps of work. But even for da Vinci in the fifteenth century perpetual motion was an absurd illusion. Stevin in 1606 assumed the impossibility of perpetual motion in mechanics, but he did not extend the assumption to all other fields. Even so acute a thinker as Huygens admitted that it might be possible in some field although not in mechanics.

In looking for the origination of the mathematical concept of energy, one's hopes are raised by a perusal of Galileo's work. Since he established the equations

$$v = gt,$$
$$s = \tfrac{1}{2}\,gt^2,$$
$$\text{and } gs = \tfrac{1}{2}\,v^2,$$

it is easy, by multiplying each of these by m, to obtain (in the usual symbols)

$$mv = mgt = Pt \quad . \quad . \quad . \quad (1)$$
$$ms = \tfrac{1}{2}\,mgt^2 = \tfrac{1}{2}\,Pt^2 \quad . \quad . \quad (2)$$
$$\text{and } mgs = \tfrac{1}{2}\,mv^2 \quad . \quad . \quad . \quad . \quad (3)$$

Mach pointed out that this derivation makes the last equation appear more remote, less fundamental, than the other two. This may well have been the view of the men of science of the seventeenth century. It is significant that Descartes used matter and motion alone in his cosmic theory—the first original synthetic account since Aristotle. The chief point of Descartes's work in this connexion was his conviction that something causal is conserved. Since his cosmology was a kind of extended kinetics, he had no use for any form of potential energy: the universe was conceived somewhat after the manner of a quantity of gas in a thermally isolated vessel. But the concepts

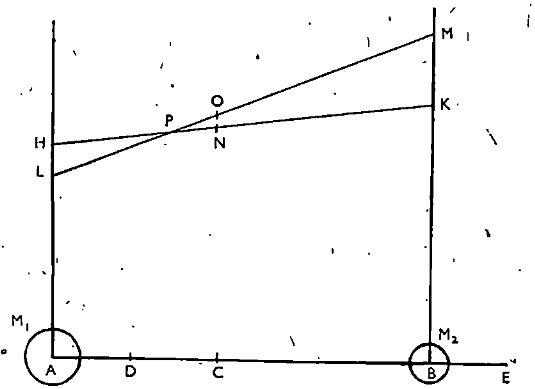

Fig. 1.

Descartes introduced were not defined satisfactorily, and his treatment of the fundamental subject of elastic collision was hopelessly erroneous.

Huygens (1629–95) was the first man of science whose investigations seriously advanced the idea of energy in mechanical systems. His work requires more detailed study because he followed Galileo rather than Descartes in seeking to render a small region of fact quantitatively intelligible and not to make all facts derivative from one central philosophy. In 1652 he commenced work on the study of horizontal direct impact. Unfortunately, his complete work only appeared posthumously. Using experiment much as Galileo had done, he built up a series of propositions which embraced a correct treatment of the conservation of momentum and of kinetic energy for this limited form of motion. Beginning with Galileo's concept of inertia, Huygens made the assumption that for bodies of perfect elasticity, equal masses meeting in a straight line with equal and opposed velocities recoiled with those velocities unchanged in magnitude but reversed in direction. He was then able to show that for unequal masses, in the case where the masses are inversely as their velocities, that is

$$\frac{m_1}{m_2} = \frac{v_2}{v_1},$$

each mass again rebounded with its velocity reversed. In deducing this theoretically he had to add to his preliminary assumptions the important principle that the centre of gravity of a system of bodies cannot rise as a result of any motion of the bodies under gravity. This was an assumption which Huygens regarded as self-evident and one which he made use of throughout almost all his work in mechanics. That its theoretical value was unknown to English men of science is evident from the surprise of Wren, Wallis and others, who witnessed experiments on impact using the ballistic pendulum in Huygens' rooms in London in 1661 and found that Huygens had a method of calculating the heights to which the pendulum bobs would ascend after collision.

In the particular theorem referred to, Huygens used the figure shown in Fig. 1.

The mass m_1 has a velocity $v_1 = AC$ and m_2 has $v_2 = BC$. After rebound, suppose m_1 possesses a velocity $v_1' = CD$, less than CA. Then m_2 must, by the conservation of momentum, possess $v_2' = CE$, for $DC + CE = AC + CB$ (the relative speeds of approach and separation being equal, as Huygens knew). The vertical descents required to give m_1 and m_2 their original speeds were HA and KB respectively, such that

$$\frac{HA}{KB} = \frac{AC^2}{CB^2}.$$

After impact these become AL and BM, such that

$$\frac{AL}{AH} = \frac{CD^2}{CA^2} \text{ and } \frac{MB}{KB} = \frac{CE^2}{CB^2}.$$

When first elevated, m_1 and m_2 have their common centre of gravity at N. After impact this becomes O (assuming the new velocities), for $m_1.AC = m_2.CB$

$$\text{and } \frac{HN}{NK} = \frac{AC}{CB} = \frac{LO}{OM}.$$

It is easy to show[3] that O must be higher than N. This contradicts Huygens' fundamental principle; hence, he argued, the speeds of approach and separation must be equal for m_1 and m_2. From this point Huygens' work shows a clear development culminating in the recognition of the conservation of energy within mechanical systems. The first step comes in a later theorem on impact, where he showed that Σmv^2 is constant: by using the square of the velocity the difficulty of taking account of signs vanishes. Huygens himself regarded the quantity mv^2 (called the *vis viva* by Leibniz) as more fundamental than the quantity of motion mv.

A closer approach to an equation for energy was, however, made in his work on the centre of oscillation of a compound pendulum. Here Huygens began by considering the simplest case of an inflexible weightless bar carrying the weights D at the lower end and E at some other point (Fig. 2). If the weights and their distances from the axis of oscillation are given, where is the centre of oscillation? Huygens' first method[4] of attacking this problem was to suppose the pendulum to be withdrawn to the position ABC. On swinging back to the lowest point, E and D are supposed to meet the respectively equal masses G and F. By the laws of impact the collision will immobilize the pendulum and the masses G and F then move with the speeds belonging to E and D at the instant of collision. In calculating the heights which G and F can attain, all that Huygens assumed was his fundamental principle that the centre of gravity does not ascend higher than it was when the pendulum was in the position ABC.

In his published work Huygens abandoned the device of the impact against equal masses which are unconnected and simply supposed the masses to be freed at some point in their paths. In the general case where there are masses A, B, C, . . . on the linear pendulum, distant e, f, g, . . . from the axis D, and these can ascend separately through the

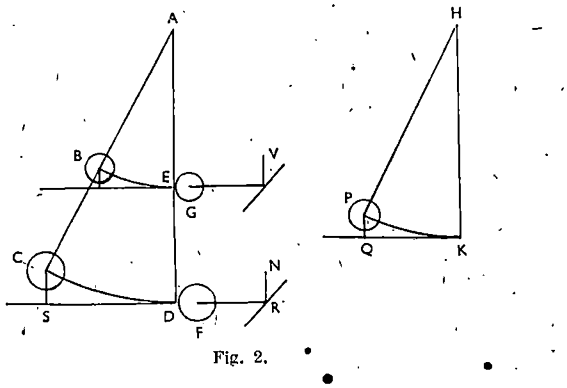

Fig. 2.

heights α, β, γ, . . . then the centre of gravity (distant d from D) must ascend a distance z and the centre of oscillation (distant x from D) a distance y. It seemed to Huygens that he might assume the equality of the swings of a compound pendulum.

By similar triangles, $\frac{x}{d} = \frac{y}{z}$ or $z = \frac{yd}{x}$.

Using $v^2 = 2gs$ we get:

$$\frac{x^2}{e^2} = \frac{y}{\alpha}.$$

Hence $\alpha = \frac{ye^2}{x^2}$; and similarly, $\beta = \frac{yf^2}{x^2}$, $\gamma = \frac{yg^2}{x^2}$.

The work done is $A\alpha + B\beta + C\gamma + \ . \ . \ .$

or
$$\frac{Ae^2y + Bf^2y + Cg^2y + \ . \ . \ .}{x^2}.$$

But this is also given by $(A + B + C + \ . \ . \ .)\ \frac{yd}{x}$.

Whence
$$\begin{aligned} x &= \frac{Ae^2 + Bf^2 + Cg^2 + \ . \ . \ .}{Ad + Bd + Cd + \ . \ . \ .} \\ &= \frac{Ae^2 + Bf^2 + Cg^2 + \ . \ . \ .}{(a + b + c + \ . \ . \ .)d} \\ &= \frac{\Sigma mr^2}{\Sigma mr}. \end{aligned}$$

All this—except the term work—is to be found in Huygens' great "Horologium Oscillatorium" of 1673[5]. It is clear that Huygens has in effect combined his fundamental principle with Galileo's relation that the velocity acquired in descent under gravity varies as the square root of the height. The speeds of suspended particles at any point in the path were then compared with the corresponding heights of descent, a procedure which really amounts, in combination with the conservation of *vis viva*, to the application of the law of conservation of energy in mechanics. It is possible from this starting point to obtain an equation showing the constancy of the sum of the kinetic and potential energies for an isolated system, namely, $T + V = H$, in the form given by Lagrange.

If any doubt remained as to the importance of Huygens' contribution to the subject of energy it must surely be dispelled by his own clear statement of his ideas. For in his MS. of 1693, two years before his death, there appears the following passage (translated from the Latin): "In all movements of bodies whatsoever, no force is lost or disappears without producing a subsequent effect for the production of which the same amount of force is needed as that which has been lost. By force I mean the power of raising a weight. Thus, a double force is that which is capable of raising the same weight twice as high"[6]. The word for force in this passage is *vis*, a word which, like *potentia*, was used in the seventeenth century in the two senses of force and energy. Unfortunately, the definition is ambiguous, but it would fit the notion of work or energy rather better than that of force in the Newtonian sense. The passage clearly reduces to this: there is something about a moving body which enables it to effect changes in the state of either itself or other bodies, and these results are quantitatively related with the cause which is the force or energy of the body. The same idea was far less clearly expressed by Leibniz about this time: ". . . it seems necessary to admit in bodies something other than magnitude and velocity unless we are willing to deny to bodies all power of action". The net result was that the Leibnizians, by making too much of the doctrine of the conservation of *vis viva* (really established by Huygens), caused a good deal of metaphysical fog to gather about the whole subject. Fortunately, Daniell Bernoulli perceived whence this metaphysical fog had come. Returning to Huygens' point of view, he formulated the principle of the conservation of *vis viva* as that of an "equality between the actual fall and the potential rise".

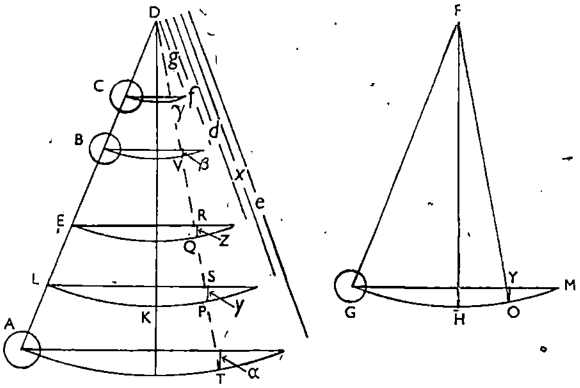

Fig. 3.

Leibniz had, on the whole, a disappointing influence. His own preference was for a world-system based on a principle of conservation of force, which latter quantity he proposed to estimate through the product mv^2. ". . . there is always a perfect equation between the full cause and the entire effect", he wrote, ". . . each complete effect is equivalent to its cause". Then, as if forestalling the retorts of later readers, he admitted "this axiom is altogether metaphysical"! It was, however, justified in his opinion on account of its use in "reducing forces to a geometrical calculus".

When we turn to Newtonian mechanics, there is in this field no great clarification comparable with Newton's treatment of other concepts. There is a passage in the "Principia" dealing with machines which states: ". . . if we estimate the action of the agent from its force and velocity conjunctly, and likewise the reaction of the impediment conjunctly from the velocities of its several parts, and from the forces of resistance arising from attrition, cohesion, weight and acceleration of those parts, the action and reaction in the use of all sorts of machines will be found always equal to one another". Tait considered that this might be reduced to the statement: work done on the machine is equal to potential energy stored up, or work done is equal to increase in kinetic energy when no energy is stored up. The general impression of Newton's writings is, however, definitely against Tait's view that Newton should be credited with a great part of the responsibility for the principle of the conservation of energy. Elsewhere Newton commented apropos the Cartesian theory: ". . . motion is much more apt to be lost than to be got". Newton did not regard the cosmic machine as perfect, and supposed that an ethereal medium supplied the necessary increments of motion to replace that lost.

It was very unfortunate that Newton and Huygens did not collaborate and that, on the contrary, profound differences of view lay between them and their followers[7]. The concept of work performed might, through Huygens' clear example, have become fundamental in mechanics long before it did. Instead, Newton used the idea of force applied for a given interval of time and this became the predominant view. There was, of course, a celebrated dispute between the Cartesians and Leibnizians on the question whether *mv* or mv^2 were the more fundamental entity to be employed in a universal conservation law. It lasted more than half a century, until brought to a close by D'Alembert in 1743. He showed that the dispute was in effect merely one concerning the best choice of co-ordinates, for *Pt* leads to the Cartesian *mv* whereas *Ps* leads to mv^2. The eccentric Cavendish seems to have reasoned out the consequences of the conservation of kinetic and potential energy in general terms. This, at least, is the view of Sir Edward Thorpe, who edited Cavendish's unpublished papers.

During the eighteenth century it became evident that physics could not be unified on kinetics; the identities of mechanics had to be traced in other phenomena. In 1787 Rumford (Benjamin Thompson) showed that there was no significant change in weight when water turned to ice; the hypothesis of the material nature of heat (and light) had soon to be given up. Text-books of physics commonly deal with these matters, though, so far as I know, they never give any experimental details for Davy's melting of ice by friction, an experiment which, on the face of it, has few claims to serious consideration[8].

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[1] NATURE, 149, 688 (1942)
[2] "Memoir of James Prescott Joule", 17 (1892).
[3] "Oeuvres Complètes", 16, 50–64.
[4] "Oeuvres Complètes", 16, 414.
[5] "Oeuvres Complètes", 18, 259.
[6] "Oeuvres Complètes", 18, 554.
[7] NATURE, 146, 511 (1940).
[8] Andrade, E. N. da C., NATURE, 135, 359 (1935).

CO-OPERATIVE SYSTEMS IN EUROPEAN AGRICULTURE

A YEAR ago the Division for the Social and International Relations of Science of the British Association held a conference on post-war European agriculture, which formed one of a series of conferences on post-war reconstruction. Since then a good deal of work has been done on the problems of agricultural reconstruction both by the governments of Allied countries in London and by inter-allied bodies like the Leith-Ross Committee. It has become clear that mportant as will be the material help which can be brought into the liberated countries from outside—the seeds, implements, fertilizers, even livestock, which will be required to restore their impoverished farms—the effectiveness of such aid will depend, both n the period of relief and the longer period of reconstruction, on the effectiveness of internal organization and the extent to which agriculture is integrated technically, economically and socially.

It was with this consideration in mind that the British Association called a second conference on April 16 and 17, 1943, to discuss the most widespread of the methods of agricultural integration in Europe, the co-operative system. The conference was welcomed by Sir Richard Gregory on behalf of the British Association. Sir John Russell, in his opening address, recalled how speakers at the previous conference, confronted with the agricultural alternatives of national self-sufficiency or a high standard of living, and of large or small farms, had, almost without exception, declared for the small farm and a high standard of living, especially of nutrition. The present conference accepted, and would have to deal with, the consequences of that decision. The disadvantage of the small farm is the overwhelmingly hard labour it demands, which bears particularly heavily upon the women. The small farm lacks machinery to lighten that toil, it lacks the capital needed to carry the farmer through the long cycle of agricultural production, and it is frequently burdened with debt. Methods of marketing are primitive and wasteful. It is the testimony of practical men that co-operation has provided a remedy for these evils. It has in addition given a technical training to the small farmer, raising his standards of cultivation and putting him in touch with modern knowledge.

The first session was devoted to the experience of Western Europe, beginning with the British Isles. Mr. Hewitt, himself a farmer and the chairman of a farmers' co-operative society in the west of England, took the co-operative supply of agricultural requirements as his main theme. He showed the large part which agricultural co-operative societies play in the handling of requirements such as seeds and feeding stuffs, grown by one set of farmers and used by another, and instanced, in particular, the distribution of the famous Aberystwyth strains of grasses and clovers and of 'once grown' seed potatoes. He looked forward to the end of the War and the urgent call from the devastated countries of Europe for agricultural requirements and supplies of all kinds, which it would be the great privilege and very pleasant duty of British farmers to meet with abundant supplies of the best qualities of seeds, seed corn and seed potatoes.

The application of co-operation to the problems of the Scottish crofters, the nearest approach to a peasantry to be found in the United Kingdom, was described by Mr. C. J. M. Cadzow, secretary of the Scottish Agricultural Organisation Society. He described how, following on the widespread failure of the crofters' potato crop in 1938, his Society had undertaken the distribution of seeds and fertilizers through the clerks to seven hundred grazing or township committees. All requirements were those recommended by the agricultural colleges as suitable to the district concerned. The Society had also arranged for the sale of the crofters' wool. The co-operative movement in Ireland, the remarkable pioneer work of Horace Plunkett and his associates guided by the formula "Better farming, better business, better living", and the world-wide influence of the movement, great out of proportion to its material achievements, were described by Miss Margaret Digby.

M. André Dulin, of the French National Committee, described the part played by agricultural co-operation in France in the provision of credit, both individual and collective, in insurance, the provision of agricultural requirements and in the processing and marketing of agricultural produce. He looked forward to the position of French agriculture at the end of the War, with soil impoverished and overrun by weeds, livestock and machinery diminished and labour reduced, since returning prisoners would be physically unfit to make much immediate contribution. It was likely also that experience of the failure of all the boasted reorganization of agriculture by the Vichy Government would have bred pessimism and suspicion of all State regulation. On the other hand, sheer necessity has brought much informal co-operation in the use of implements and transport facilities. The hope of the future lay in the professional reorganization of agriculture on the lines of voluntary co-operation.

M. Borremans, agricultural attaché to the Belgian Embassy, concluded the session with a sketch of agricultural co-operation in Belgium under the leadership of the well-known Boerenbond Belge, with its simultaneous concern for technical advance and instruction, social welfare and economic prosperity.

The second session was devoted to the northern countries lying about the North Sea and the Baltic, all having in common a strong dairy element in their co-operative economy. The chair was taken by Dr. C. R. Fay, reader in economic history in the University of Cambridge. Agriculture in these countries, he said, is based on the family farm, but it is not a peasant economy ; it is the family farm, commercialized, mechanized and specialized, and the conditions of its success are two : State guardianship of the land unit, which can neither be merged in the large estate nor fragmented into the dwarf holding, and co-operative economics. Adjustment to an export market is not the secret of Scandinavian success in co-operative organization. It must be sought rather in the high intelligence of the participants, based on high education, in democratic feeling, and in the integrated and dynamic character of the movement. All this can be seen not only in the countries represented at the conference, but also in Finland and Iceland.

Mr. P. A. Moltesen, agricultural attaché to the Danish Legation, described the spontaneous origin of Danish co-operation and its specialized character, with one function for each type of society, and its corollary, multiple membership by each farmer, and the final linking of all societies in a national federation which exerts considerable influence upon the economic policy of the country. Mr. S. Krolikowski (Poland) spoke of co-operation as the means by which the peasant farm can effect the difficult transition between self-sufficiency and participation in a capitalistic economy, and can combine individual land ownership and cultivation with collective action in purchase, manufacture and sale. Co-operation, again, is the best channel of technical instruction for the farmer and the means of stimulating him to adopt more scientific methods. Before the War, 50,000 students were accommodated in co-operative schools. During the War, though their educational work has ceased, there is reason to believe that the agricultural trading co-operatives are still in use and developing, since they were too strong for the enemy to destroy without an adverse effect on the production-level. After the War their part would grow still more, in the organization of food supplies and the replanning of agricultural economy. Mr. Fjelstad, minister in the Norwegian Cabinet, sketched the development of co-operation in Norway both in farming and forestry, where co-operative insurance and the organization of a fireguard service have saved considerable national assets from destruction. He described how the already developed co-operative dairy system enabled the Norwegian milk marketing board to be organized from the bottom up and not, as in Great Britain, from the top downwards. Mr. Gerritzen, agricultural attaché to the Netherlands Embassy, spoke of the many-sided co-operative organization of his country, the part it has played in the development of the famous market garden industry of the Netherlands, and its bold and successful entry into the beet sugar industry. In the discussion, other speakers referred to the co-operative movements of the Baltic States and Iceland.

A further session of the Conference was devoted to a somewhat different aspect of the immediate post-war problem, the emergency distribution of food. In this the farmers and their organization have a part to play, since every country must rely fundamentally on the food which can be produced within its own borders. But in the first few months of liberation every European country will be dependent on emergency supplies hurried into its towns and industrial areas—sometimes even into its rural areas—from overseas. These supplies will have to be distributed, as will those delivered from the country as soon as normal transport has begun to work. Distribution in such emergency conditions may not be easy to improvise and the normal channels of trade may be blocked or unsuitable. In these circumstances, the existence of a consumers' co-operative movement, whether catering mainly for the industrial population, as in Great Britain, or of a rural character as in many Continental countries, may well be of the highest value to the relief administrator or newly restored national government. It has the machinery of distribution, it serves public ends and enjoys the confidence of its members.

Mr. J. McFadyen, of the Co-operative Wholesale Society, opened the session with an account of the experience of the British co-operative movement in distributing foodstuffs in periods and areas of heavy bombing. He described the way in which neighbouring societies have come to one another's assistance. In one case where all the bakeries of a city were temporarily put out of action, nearly two thirds of the necessary supplies were sent in from the co-operative bakeries of other towns and distributed both to co-operative members and others. Repairs to co-operative premises anywhere were the immediate concern of a central C.W.S. building department. Dispersal of essential stocks is made easy by the wide network of co-operative societies and the mutual understanding which exists between them. This account of actual and recent experience was followed by a survey from Mr. R. A. Palmer, acting chairman of the International Co-operative Alliance, of the actual resources in productive and distributive machinery, as well as in membership, of the co-operative movements in Europe, resources which, in spite of the restrictive and in some cases even destructive action of the occupying enemy authorities, will, it is hoped, be available to those who have to administer the distribution of food in the first difficult weeks after liberation.

Precisely how difficult those weeks may be was made plain in an address by Mr. J. Kwapinsky, Minister of Social Welfare in the Polish Government, who described the appallingly low level of rations which have been in force in Poland for a long time past : rations of 600–800 calories daily for the Polish Christian population and of less than 300 calories for the Jewish populations, in both cases below minimum physiological need. Relief of the town populations of Poland would have to be given with all possible speed. The enemy has destroyed private trade, and controls food distribution largely through the pre-war co-operative system, which is dominated but not destroyed. The supervision of food distribution in the post-war period will have to be transferred to the revived Polish local authorities, but for actual distribution in emergency circumstances, the co operatives would be the most elastic system with the necessary commercial knowledge and storage and transport facilities. On their commercial efficiency in collecting home-grown food, in which agricultural co-operatives would also play their part, would depend in large measure the successful mastery of the 'black market'. On the efficient distribution of food from abroad would depend the speed of agricultural reconstruction, since no reconstruction could be attempted until such phenomena as the reckless slaughter of livestock for food has ceased. These conclusions were reinforced on the administrative side by Mr. R. Kreisky, speaking for Czechoslovakia, and on the nutritional aspect of the problem by Dr. Magnus Pyke of the British Ministry of Food, who described the very interesting inquiry into nutritional conditions in an industrial suburb of Madrid, carried out by the Rockefeller Foundation in the summer of 1941. This, while access to occupied Europe was impossible, provided the best indication of the sort of conditions which are likely to be found among the liberated peoples. The main conclusion was that the fundamental condition was a shortage of calories rather than deficiency of any particular constituent. The diet was pitiably scanty but not grossly unbalanced.

At its last session, the conference returned to the agricultural and productive, rather than the distributive, aspect of co-operative organization, and considered the experience of countries in Eastern Europe, Czechoslovakia, Yugoslavia, Greece and the Soviet Union. Dr. Bicanic (Yugoslavia) looked beyond the organization of co-operation on the 'classic' pattern of local and voluntary association, already developed with a varying measure of success in the different regions of Yugoslavia before the War. He envisaged a type of co-operation which would embrace the entire village community, deriving from the old Slav principle of the 'Zadruga', or family group, which is still a living force. Such a village co-operative would not be a collective in the Russian sense, but it would carry out a complex of services usually divided among separate co-operative societies, local authorities or individuals, or in many rural communities wholly neglected. A movement in this direction was developing spontaneously before the War; the post-war task would be to foster and extend it. Mr. Hodza (Czechoslovakia) showed how the strength of the co-operative movement had been built up by voluntary effort in the days of Austrian and Hungarian rule, and how under the Republic it was able to take a leading place in national economy. Mr. Polychroniades (Greece) looked to the reconstruction of Greek agriculture and the raising of the peasants' standard of living through a much more extensive application of co-operative methods. Dr. Barou concluded the review of European experience with an account of the wholly different application of the co-operative principle in the Soviet Union, where collective ownership of land and collective application of labour have replaced the individual peasant farm and, with the increased size of the unit and the State control of banking and commerce, the ordinary economic functions of the co-operative have disappeared.

The final impression left by the Conference was of the strength, ubiquity and diversity of the co-operative movement in Europe, and of the extent to which it is, and will doubtless remain, the principal instrument of raising both the technique of European farming and the social conditions of the peasant.

THE IMPERIAL INSTITUTE

JUBILEE OF OPENING BY QUEEN VICTORIA

By Dr. H. A. TEMPANY, C.M.G., C.B.E.

On May 10 the Imperial Institute will have reached the fiftieth anniversary of its opening by Queen Victoria. In normal times such an event would doubtless have been marked by some public ceremony appropriate to the occasion, which possesses, in certain respects, a unique historical interest. Under war-time conditions this is precluded, of course, but at least the event warrants some examination in brief retrospect of the history of the Institute and the part which it has come to play in public affairs to-day.

The genesis of the Institute occurred in 1887, when its foundation as a memorial of the golden jubilee of Queen Victoria was undertaken. Its first president was the then Prince of Wales, afterwards Edward VII, under whose direct guidance the Institute was organized. It is, therefore, a relic of the zenith of the Victorian era, those spacious days when the political skies appeared serene and unclouded and there was scarcely more than a hint of the grievous troubles which were to assail the world during the ensuing half-century.

The general objects which the Institute was founded to fulfil were to promote the development of the British Empire and to foster relationships between its numerous component territories and the mother country. Specifically, it was intended to promote the development and utilization of the resources of the Empire, to foster new forms of production as well as the processing and marketing of Empire products, to collect and disseminate information concerning the Empire, its peoples and its products, and later it was instructed to advise on the availability and utilization of its raw materials for Imperial defence. Concurrently it was intended that it should collect samples and specimens of Empire products, and establish and maintain exhibition galleries open to the public, which would serve as an indication and a reminder of the character of the Empire and of the vast resources which it contained. It was also envisaged that the Institute should serve as a link between the various parts of the Empire and a focus and a meeting-place from which would emanate new projects and schemes in connexion with Imperial development.

The concept had at that time a certain novel grandeur, and, associated as it was with the immense and now almost legendary affection, esteem and veneration in which Queen Victoria was held, it made an immediate popular appeal; as a result the large sum—for those days—of £400,000 was raised from official and private sources to launch the project. Of this sum £250,000 was devoted to erecting the impressive building in South Kensington, in which it has ever since been housed; the remaining £150,000 was constituted into an endowment fund.

The first director was Sir Frederick Abel; he was succeeded in 1903 by Prof. (afterwards Sir Wyndham) Dunstan, who retired in 1925 and was succeeded by Sir William Furse. The present director, Sir Harry Lindsay, succeeded Sir William Furse in 1934.

After its inauguration the wave of enthusiasm evaporated, while the available revenue from the endowment fund and other sources proved inadequate to enable it to fulfil its functions. Consequently it had to face financial difficulties. In 1900 a part of the building was made over to the University of London, which has continued to occupy it until the present time.

In 1905 the Institute was placed under the control of the Colonial Office and so remained until 1925, when its position was reviewed and it was given its present constitution under the Imperial Institute Act of 1925.

Under this the Institute is vested in a statutory Board of Trustees, while its governance is entrusted to a Board of Governors, of which the president is the Secretary of the Department of Overseas Trade, and membership comprises representatives of the Dominions and India and of the Treasury, the Board of Trade, the Colonial Office, the Ministry of Agriculture and Fisheries, the Department of Scientific and Industrial Research as well as of the Royal Society and certain other scientific and commercial bodies.

At the time of its reconstitution, the Institute absorbed the Imperial Mineral Resources Bureau, which had been previously operated as a separate organization. The revenues of the Institute are now derived from the endowment fund, from grants made by the United Kingdom Treasury and by the Governments of the Dominions, India, Burma and the Colonies and Mandated Territories as well as from fees and rentals. The total income and expenditure balance at about £48,000 per annum. The bulk of the income is now contributed by Empire Governments.

The history of the Institute has thus been somewhat chequered; it was only after a rather prolonged initial period that it settled down to the fully efficient discharge of its functions. These nowadays comprise, on one hand, laboratory investigation of Empire raw materials, and the collection and dissemination of technical and commercial information concerning the raw and semi-manufactured products of the Empire, and on the other, the maintenance of its exhibition galleries and the related educational services designed to provide instruction to the general public concerning the British Empire, its peoples, its products and its general character.

In regard to the former, the Institute has during the fifty years of its existence succeeded in building up an information service which is almost certainly unrivalled in its own particular sphere. It is organized in two departments, a plant and animal products department and a mineral resources department, each under the charge of a scientific officer; each department is provided with a technically trained staff, all of whom have the standing of graduates of a British university or possess equivalent qualifications. The staffs in both cases are again subdivided into an intelligence section and a laboratory section. The former is concerned with the collection, recording and dissemination of information, and with replying to the great number of technical inquiries which flow to the Institute from all parts of the Empire, the latter with the examination and technical trial of materials submitted to the Institute. A careful and extensive card-index system epitomizes the sources of information about raw materials of all kinds. The Institute is, under its constitution, debarred from undertaking fundamental research, but is expected to investigate and report upon materials submitted to it. As many of the products submitted are novel in character and as at times their examination may call for the development of new technical methods, the distinction between investigation and research may, it is anticipated, at times present not inconsiderable difficulties.

The work of the departments is assisted by two advisory councils, one dealing with plant and animal products, the other with mineral products; while associated with them are fifteen consultative committees each dealing with a special product or group of products, the membership of which is composed of scientific, technical and commercial authorities on the particular subject with which each committee is concerned. The set-up thus provided is well adapted to provide an efficient advisory service, and it can be truthfully said that, at any rate of recent years, no query on a subject falling within the scope of the Institute's functions has been received to which an answer has not been returned embodying the latest available information.

The results of more important inquiries are published in the quarterly *Bulletin* of the Institute, while an extensive series of monographs on a wide range of subjects is also issued. Special mention should also be made of the annual statistical summary of the mineral industry of the Empire and foreign countries issued by the Institute, which enjoys an international reputation.

The library of the Institute also deserves special mention; it contains more than 75,000 volumes, including all technical journals relating to its work; its facilities are freely available to workers.

On the publicity side, the Exhibition Galleries of the Institute are noteworthy, for, in addition to providing a range of exhibits and samples which illustrate with a wealth of detail the products and resources of Empire countries, by means of photographs and admirably devised and mounted dioramas they enable the inquiring visitor to obtain a reasonably accurate impression of conditions in many parts of the British Commonwealth. Associated with this is a library of Empire films and lantern slides, which are available for loan to schools and other institutions, while arrangements exist for the provision of lecturers to deliver discourses on a wide range of subjects connected with the Empire. The attack which the Institute has been able to make on the widespread ignorance in the United Kingdom concerning conditions in the Dominions, India and the Colonial Dependencies indeed represents one of its major achievements. During 1942, for example, more than 4,400 films and 836 sets of lantern slides were issued to borrowers for display at a great variety of schools, adult organizations, hospitals, army, navy and air force units and many others. Nevertheless, considerable though this achievement has been, it needs to be multiplied to a great extent before the position can be considered as entirely satisfactory.

During the War, the activities of the Institute have of necessity been diverted to some extent from their normal channels. A number of members of the technical staff have been temporarily transferred to the Ministry of Supply and other temporary wartime organizations of Government, while twenty-two of the technical and general staff are serving with the Armed Forces. To those that have been left has devolved the duty of maintaining its activities, which have not appreciably diminished, although there has been some shift in the nature of the inquiries received, many of them being concerned with finding alternative sources of supply of commodities which have been cut off as a result of war conditions. Until recently, also, the Exhibition Galleries have been closed to the general public, although facilities have been accorded for visits by organized parties, of which there have been many applications. On the other hand, the demands for loans of films, lantern slides and the provision of lecturers have, as might be expected, increased.

After fifty years, one is entitled to ask how far can the Institute claim to have fulfilled the objects with which it was founded. Certainly in some respects it has not entirely fulfilled them; thus it has never been able to play the predominant part as a centre for the organization of intra-Imperial activities which was originally foreseen for it. No doubt this is partly the result of the preoccupation of those responsible for its destinies in its early days with the immediate difficulties of finance and management. It is true that the Institute has attracted to itself a number of related activities which although they are operated as independent units still come within its general ambit; as examples may be mentioned the office of the Trade Commissioner for Burma and the investigational work carried out by the London Advisory Committee for Rubber Research. It is also true that a much larger number of new developments have come into being, covering a wider field, which are operated independently of the Institute; examples of these are the Imperial Agricultural Bureaux and the Imperial Economic Committee; the Dominions, India and many of the Colonial Dependencies have also set up information agencies and bureaux which operate independently of the Institute. There is free and friendly collaboration between the Institute and all these organizations, but it seems reasonable to suppose that the original intention, when the Institute was first envisaged, was that all activities of this nature should come within the ægis of the Institute.

It is a matter for speculation whether the course which events have actually taken may not in the long run have been preferable to that originally envisaged, and in any event the position is now firmly established.

On the other hand, the Institute has unquestionably amply fulfilled the role which was laid down for it as a centre for the investigation of raw materials and the collection and dissemination of information concerning the products of the Empire, while its publicity and educational work within the limits of the resources available could scarcely be bettered, although there is probably scope for their considerable further extension provided the necessary finance could be provided.

On balance, therefore, it must be admitted that the Institute has gone far towards achieving the expectations which were entertained when it was founded; it occupies a unique position and renders services of great value in many directions which would otherwise be unprovided. It may indeed be said that, as it stands to-day, it is a not unworthy memorial of the great Queen whose golden jubilee it was designed to commemorate. It is to be hoped that during the next fifty years its progress will continue unimpeded, and that in the post-war era there will occur the further expansion of its activities and utility for which abundant opportunity exists.

OBITUARIES

Mr. E. Heron-Allen, F.R.S.

EDWARD HERON-ALLEN, who was born in London on December 17, 1861, was educated at Harrow, where his natural aptitude for microscope work was roused. Necessity, however, led him to study law, and in 1884 he was admitted a solicitor. He followed his profession very successfully for some years, but his inclinations lay in other directions and were always asserting themselves. Ultimately he was in a position to follow them completely, and thenceforth the Foraminifera received his main attention.

Heron-Allen had, however, already published a "Prolegomena towards the Study of the Chalk Foraminifera . . ." in 1894, but from about 1908 onwards for the next twenty-five years the results of his researches flowed fairly regularly. Throughout the greater part of that time, Heron-Allen's work was done in close association with Mr. Arthur Earland. Their papers covered not only British foraminiferal faunas (for example, Selsey, the North Sea, west of Scotland, Clare Island, Plymouth) but also those of far distant parts of the world, such as the Kerimba Archipelago and areas visited by the *Terra Nova* and *Discovery* expeditions. Nor were older faunas ignored, and publications on the Foraminifera of the Eocene of Biarritz (1919) and the Miocene of Moorabool, Victoria, Australia (1924) ensued. The room in the Zoological Department of the British Museum (Natural History) allotted to the two partners became the store-house of a magnificent collection of Foraminifera, to which Heron-Allen added other historic collections. It also housed a unique library concerning the group, a library which contains rare works and original MSS. and drawings of Foraminifera. Heron-Allen generously presented these to the Museum some years ago. He was elected a fellow of the Royal Society in 1919, was a member of numerous other societies, and during 1916–18 was president of the Royal Microscopical Society.

Although most of his work was on systematics, Heron-Allen was interested in other aspects of the Foraminifera, and he read a paper on their bionomics to the Royal Society in 1915. For him the Foraminifera were essentially living creatures, and he epitomized this in a favourite lecture of his (and he was a fascinating lecturer) on purpose and intelligence in the Foraminifera. In his approach to systematics Heron-Allen was a faithful disciple of H. B. Brady, and his classification of the Foraminifera was based on the one used in that author's memorable *Challenger* Report. If, for a long time, he was impatient of the many new genera and species erected by oil-palæontologists, it was because so many of them, especially at first, were the product of immature work and scant knowledge of variation within even well-known and abundant species. He was also initially sceptical of the claims by oil-palæontologists of the value of the Foraminifera in the search for oil, though, when the basis of their work was explained to him, his attitude became much more sympathetic to them and to the changes in foraminiferal nomenclature that have been made.

But Heron-Allen was a man of great vitality which expended itself in more than one way. For many years he lived at Selsey and he wrote on its geology, archæology and history; for example, "Selsey Bill: Historic and Pre-Historic", published in 1911. He was no mean horticulturalist, and in 1928 was president of the National Auricula Society. The violin was a life-long attraction, and so early as 1882 he had published an essay on violin-making. Witty, cultured and well read, Heron-Allen was an entertaining conversationalist, and he frequently pointed his remarks by an apt quotation from one of the many languages, classical and modern, which he knew. Of these, Persian held pride of place, and in 1898 he published a literal translation of the Bodleian MS. of the "Rubáiyat of Omar Khayyám", and in 1899 what was really a defence of the accuracy of Fitzgerald's well-known poetical translation. His many-sided character even found a place for palmistry and circus-riding while on a visit (1886–89) to America! He was district commissioner of Boy Scouts for South-west Sussex during 1910–19, while in 1918 his talents were used in the Staff Intelligence Department of the War Office.

As a friend Heron-Allen was staunch and generous, embarrassingly so sometimes; as an opponent, he was tough and unyielding. He typified in his person and character much of the late Victorian era, and he was a connoisseur in all that he took up. He was twice married. The tragic death of his younger daughter some years ago, when she was on the threshold of a promising zoological career, was a blow from which he never really recovered. Pneumonia took toll of his strength in the autumn of 1941, but his gay, fighting spirit never gave in. He died at his home at Selsey on March 28, and is survived by his wife and one daughter.

H. Dighton Thomas.

NEWS and VIEWS

Hydro-Electric Development in Scotland

This is an opportune time for any information about rainfall and run off in the area comprised in the Hydro-Electric Development (Scotland) Bill now before Parliament (see Nature, Feb. 13, pp. 177 and 187). Before us we have two reports and a memorandum by Captain W. N. McClean, founder and director of the River Flow Records Organization. The first report is on "River Flow Records of the Ness Basin 1929–1942". It describes the measurements made on the rivers feeding into Loch Ness and on the River Ness which drains the Loch. The report shows that the author has had to carry out his work with very limited means for equipment, maintenance and labour—clearly much of the latter has been voluntary. As the local authorities of Inverness have now agreed to maintain the author's records of the Ness Basin, their value is obvious. The second report, published in January last, is on "The Water Resources of Loch Quoich". This Loch feeds Loch Garry, which in turn feeds Loch Oich—a small loch near Loch Ness on the Caledonian Canal. Capt. McClean regards Loch Quoich as one of the sources of possible water-power and one of the gems of Scottish scenery. From records over some twelve years, he has no doubt that 15,000 kilowatts continuously can be developed here without considerable cost in dam construction for storage.

In his memorandum, Capt. McClean emphasizes the need for an Inland Water Survey of Great Britain to obtain correct hydrological data. He is not satisfied that rainfall statistics suffice; also he pleads for water records to be removed from all sectional interests. "There are," he says, "certain figures in the year-book ["Surface Water Yearbook" of the Inland Water Survey Committee appointed in 1935 by the Ministry of Health] which are grossly and intentionally wrong, and they would seriously affect the figuring out of the capacity of Power Schemes in an important area of Scotland. Other figures are just missing, because it might be inconvenient to divulge them." Enough has been said to give an idea of Capt. W. N. McClean's work and of the views he has formed. From facts disclosed in the Cooper Report, it follows that, in face of indifference and discouragement, pioneers like Capt. McClean needed much faith to carry on in all the vagaries of Scottish weather.

Avalanche Research in Switzerland

During the War of 1914–18 the number of avalanche fatalities among the armies in alpine regions was very high; in the period between the two wars, the influx of winter visitors to the Alps was followed by an alarming increase in accidents due to inexperience in snow-craft. It became obvious that a proper study of snow and avalanches was needed. There followed the private research work of individuals in many parts of Central Europe, who in turn were succeeded by more elaborately organized groups. In 1934 the Swiss authorities inaugurated a small research laboratory on the Weissfluhjoch close to the upper end of one of the Davos funiculars at a height of 8,500 ft. Under the direction of Dr. H. Bader, a crystallographer, and Dr. M. Haefeli, a civil engineer, much valuable work was carried out ranging from the purely scientific to the severely practical. The former has given us a great deal of new knowledge of the structure and behaviour of ice crystals, such as their rearrangement into regular order under stress with its clearly defined metallurgical analogy. Among the latter were such tests as the reaction of different types of snow to varying meteorological conditions and the resulting tendency to increase or decrease avalanche danger. The drawing together of the many threads of research followed and the results, combined with the investigations of practical men in the mountains, have been of the greatest value in bringing about a closer understanding of, and so mitigating, avalanche dangers. An excellent publication of some 340 pages was produced in 1939 recounting the field and laboratory work up to the end of 1938, and subsequent publications have also appeared.

Originally the governing body of the Weissfluhjoch station was the Swiss Commission for Snow and Avalanche Research under the chairmanship of the head of the Federal Forestry Department and working in conjunction with many Swiss men of science, chief of whom was Prof. P. Niggli, the mineralogist, of Zurich, and including many experts in cognate subjects such as Dr. Mörikofer, of the Meteorological Observatory at Davos. It was largely financed from unofficial sources. A recent press notice stated that the Swiss Government has opened a new research institute on the Weissfluhjoch, which we assume to be a development of the earlier laboratory, perhaps more on the lines of the research institute on the Jungfraujoch. Possibly it means the commencement of its existence as a separate department of the Ministry for the Interior, with more adequate funds for effective research than its semi-private forerunner had been able to command.

Metallographical Research in Sweden

A SPECIAL committee appointed by the Swedish Government to investigate the need for new research institutions has recently submitted a proposal for the establishment of a new institute for iron and steel research, called the Metallographical Institute. In common with the new Swedish Wood Research Institute and the Chemical Research Institute in their respective spheres, it will be a central institution for carrying out metallurgical research in close co-operation with the various iron and steel works in he country, the Swedish Ironmasters' Association, etc. The present Metallographical Institute in Stockholm will be incorporated in the new institution. In its proposals the committee points out that Sweden's export of iron and steel products is mainly dependent upon the country's ability to produce high-quality, so-called 'fine' steel and steel products. To keep these products up to the highest standard and yet to be able to produce them at competitive prices will demand unremitting research. It is proposed to erect the new institute near the Royal Technical University of Stockholm, and it will thus onstitute a new addition to the 'City of Science' hat has grown up around that institution in recent years. The building costs are estimated at about £70,000, and those for the equipment at £30,000. It s suggested that the State shall pay for the erection nd maintenance costs of the buildings, while Swedish industry shall undertake to bear the expenses or the equipment and the research work.

Artificially Dried Grass

THE "Production of Artificially Dried Grass" is the title of Bulletin No. 8 by J. McNair and A. B. owler, published by the Hannah Dairy Research Institute. While it is realized that extension of grass drying is unlikely during the war period owing o the shortage of labour, machinery and fuel, the need for home-grown protein-rich feeding stuffs will ontinue after the War, so that if the problems nvolved in the various stages of the process are properly understood now, it will do much to ensure that future developments are on a sound basis. The eport is, therefore, intended to be informative rather than conclusive, and the results, obtained from ractical experience on a small (120 acres) dairy farm in Ayrshire, throw considerable light on the somehat conflicting views now held as to the economic ossibilities of the process. The greatest variations are found in the cost of producing the raw material. part from manurial treatment the weather is chiefly esponsible for this. High-grade material needs to be ut young, and difficulty is experienced in maintaining good quality owing to the seasonal fluctuations in the growth-rate and the relatively high costs of cutting and collecting young herbage. A judicial use of fertilizers is, however, profitable particularly if arrangements are made for ensiling any surplus material.

The operation of the drying plant itself offers fewer difficulties than the production of suitable grass, though there is still a need for a capable drier and ancillary field equipment at a moderate price. Maintenance charges, however, on both cutting and drying machines have hitherto been underestimated, and before grass drying can be recommended for adoption as part of the normal operations on an average-sized farm, costs must be further reduced and the quality of the product improved. The position may best be summarized in the final words of the Bulletin, "that viewed in the light of possible future developments, the practicability of grass drying is still an open issue, and one vital to British agriculture".

Polish Science and Learning

WHEN eastern Europe has been devastated and its indigenous culture suppressed, it is particularly gratifying to find a band of refugee professors and lecturers combining to keep the stream of their learning from drying up. *Polish Science and Learning* (No. 2, February 1943, Oxford University Press) is the second of a series of booklets prepared by Polish scholars in Great Britain in collaboration with their British colleagues. An article by Charles Elton on "The Changing Realms of Animal Life" is contributed as "something new towards maintaining the concept of international co-operation in science after the war is 'over'', and the same ideal lives in the messages from Sir James Colquhoun, Sir John Russell, and Prof. A. V. Hill. Articles by Poles (some of them, for reasons of security, writing pseudonymically) deal with "The Future of the Inland Waterways of Poland in the General Trans-European Network", "Problems of Economic Geology in Poland", "Marian Raciborski and the Advancement of Botany in Poland", "Development of Polish Hydrobiology" and "Polish Painting". The booklet strikes a sombre note with its obituary notices and list of losses among Polish scholars during the War, but the account of "Polish Educational Activities in Exile" rings with confidence in the future.

Health of American Troops Abroad

ACCORDING to an editorial article in the December issue of the *Statistical Bulletin*, the health of American troops in Great Britain and other places in the temperate zone has been maintained at an extraordinarily high level. On the other hand, a host of new problems is being found in the tropical and subtropical regions in the form of insect-borne diseases such as malaria, typhus, dysentery, yellow fever, plague and cholera. Of these, malaria is by far the most serious problem. Its control is difficult as there is no specific prophylactic method. The disease, however, can be checked by routine administration of quinine or synthetic drugs, especially atabrine. Intestinal disorders, including dysentery, are also a serious problem in the tropics. Preventive control requires strict adherence to sanitary methods and instruction of the men to protect themselves. Typhus is not confined to eastern and south-eastern Europe; North Africa is an important focus of the disease, as is shown by the fact that severe epidemics have occurred recently from Morocco to Egypt. Immunization has been applied, but its value has still to be confirmed. The incidence of illness due to exposure to heat is far less among seasoned troops than among new arrivals. In conclusion, the article states that sickness- and death-rates among the American troops are appreciably lower than during the War of 1914–18, in the tropics as well as in other regions.

Recent Earthquakes

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentres of three recent earthquakes. These determinations were based on instrumental data received from the seismological observatories at Weston, Mobile, Tucson, Georgetown, Chicago, Burlington, Fordham, Buffalo, Philadelphia, Tacubaya, Honolulu, Lincoln, Pasadena, St. Louis, San Juan, Sitka and Huancayo. The first earthquake was on January 24, and took place at 20h. 42·1m. U.T. from an epicentre near latitude 15° N., longitude 91° W. This is south-east of Sta. Cruz Quiche in Guatemala, Central America. The second shock occurred on January 27 at 2h. 45·2m. U.T. from an epicentre near latitude 52° N., longitude 180° W., which is in the North Pacific Ocean in the Aleutian Islands Archipelago between Rat Island and Tanaga Island. Both these earthquakes had a normal depth of focus. The third earthquake here detailed took place on January 30 at 5h. 33·0m. U.T. from an epicentre near latitude 2° S., longitude 80° W., which is very near to Guayaquil in Ecuador in South America. This earthquake had a depth of focus probably about 100 km., which is below normal, though not unexpected in the region in question. All these epicentres are in well-known seismic regions.

New Seismograph in Mexico

The State Government of Puebla, Mexico, has acquired a Benioff vertical-component seismograph, to be installed at the National Astrophysical Observatory at Tonantzintla, State of Puebla. This instrument is now on the way to Mexico. This modern seismograph has been purchased from the National Research Council of Washington, D.C., through Dr. Harlow Shapley, director of the Harvard College Observatory, who made the necessary arrangements, in which the State Government of Puebla was represented by the Mexican Embassy in Washington. The instrument is identical with that installed in the Harvard Seismological Station; it is of the latest model available and is a valuable addition for scientific investigation in Mexico.

Health in Paris

According to an article in the *Journal of the American Medical Association* (Jan. 22, 1943) no important epidemic has broken out in Paris since the beginning of the War except smallpox at the beginning of 1942, which was checked by intensive vaccination. Cases of scabies have increased from 1 to 70 per cent. Tuberculosis has doubled among 6–8-year old children and adolescents of 18–25. No general mortality figures have been published, but the annual rate of deaths at the Cochin Hospital has increased from 1,200 to 1,400. All Paris hospitals suffer from increasing transport difficulties.

The Nutrition Society

The Nutrition Society has arranged a whole-da conference on "Nutrition in Infancy" to be held o May 22, at the London School of Hygiene an Tropical Medicine, Keppel Street, W.C.1, beginnin at 10.30 a.m., with Prof. L. G. Parsons in the chai The following papers will be read: (1) "Nutrition Needs in Infancy" by Dr. H. M. M. Mackay; ("Recognition of Nutritional Disorders in Infancy by Wing-Commander R. W. B. Ellis; (3) "Trea ment of Nutritional Disorders in Infancy" by D A. A. Moncrieff; (4) "Public Health Aspects" b Dr. J. C. Spence and Dr. H. E. Magee. The di cussions after the four papers will be opened b Prof. Noah Morris, Dr. S. G. Graham, Dr. J. V. Braithwaite and Mr. F. le Gros Clark, respectivel Further details of the meeting can be obtained fro the Hon. Secretary, Dr. Leslie Harris, Nutrition Laboratory, Milton Road, Cambridge.

Announcements

The Lord President of the Council has appointe Dr. Charles S. Hanes to be director of food invest gation in the Department of Scientific and Industri Research. Dr. Hanes is at present serving with th food mission in North America, his services havin been made available by the Department of Scientifi and Industrial Research to the Ministry of Food f this purpose. The date from which he will take u his new post has not yet been fixed.

The thirty-third annual May Lecture of th Institute of Metals will be delivered by Prof. G. Thomson, in the Hall of the Institution of Mechanic Engineers, Storey's Gate, Westminster, S.W.1, o May 19, at 6 p.m. Prof. Thomson will speak o "Electron Diffraction".

Under the terms of the James Scott Prize (194 Prof. E. A. Milne delivered an address entitled "Th Fundamental Concepts of Natural Philosophy" a the ordinary meeting of the Royal Society of Edin burgh on May 3.

The title of reader in medicine in the Universit of London has been conferred on Dr. Clifford Wilson in respect of the post held by him at the Londo Hospital Medical College.

The Chadwick Trustees are offering three prize of £100, £50 and £25 respectively (accompanied, the trustees so decide, by a Chadwick Medal Medals), for the best three essays, received befo September 1, on architectural, engineering an administrative principles (relative to sanitation an hygiene) which should be observed in the replannin arrangements of war-devastated towns or area Further particulars can be obtained by sending stamped, addressed envelope to the Clerk to th Chadwick Trustees, 204 Abbey House, Westminste S.W.1.

Erratum.—Referring to the letter entitled "Mod of Chemical Action of X-Rays on a Non-Aqueou Solution" in Nature of April 17, p. 448, Dr. Broda writes: "In expressing the analytical data terms of amounts of persulphate, a factor 3·0 wa overlooked; the figures in column 1 and 3 of th table should be divided by this factor. The resul expressed in the last column (percentage decrease pe unit dosage) remains, of course, unaffected.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Autumn Sexual Behaviour and the Resident Habit of many British Birds

It has been shown experimentally that the autumn migration urge of redstarts, *Phœnicurus phœnicurus* L., can be eliminated by injections of sex hormone[1], and evidence has been summarized and discussed[2] which indicates that the sexual behaviour and lack of southward migration in autumn in the British subspecies of the starling, *Sturnus vulgaris* L., are due to the partial recrudescence of the gonads at this season. In the Continental race of starling the summer regression of the gonads is more complete and there is no sign of gametogenesis in autumn. Consequently in this race interest in, and attachment to, the nesting places become sufficiently weakened to release the birds for the southward movement. The presence of sexual behaviour in autumn and an associated lack of southward migration have also been described[3] in the British robin, *Erithacus rubecula* L., and recently a survey of ornithological literature by Morley[4] has shown that such an association is present in many other British species at this time of year.

It seems reasonable to suppose that resident British birds are insular forms derived originally from the main Continental species. That is to say, they are derived from birds which were, and still are, migratory. In the milder climate of the British Isles migration is not a necessity for them, and, in fact, Britain is used as a wintering area by many of he Continental members of these species. The change to a non-migratory habit appears to have occurred independently in a large number of unrelated groups and species, being shown, for example, by most British crows (Corvidæ) and by several hrushes (Turdidæ) and tits (Paridæ). The very number so changing indicates the advantage to be gained by the elimination of long and exhausting journeys, and probably as many British species as he food supply will allow have abandoned the migraion habit. Omnivores like the starling and the rook, *Corvus frugilegus* L., and seed-eaters like the chaffinch, *Fringilla cœlebs* L., are able to remain in Britain all the year round, although some species such as the ong-tailed tit, *Aegithalus caudatus* L., and the goldcrest, *Regulus regulus* L., because of their small size, re so close to the borderline of danger that in xceptionally cold winters almost all may be frozen o death.

The mechanism by which this change of habit has apparently been achieved, at least in some species, s most interesting. It seems that the southward migration urge, which is either induced or allowed by deficiency of sex hormone, has been overcome by he autumn activity of that part of the anterior pituitary gland which causes gonad growth and sex hormone secretion. It is a natural experiment comparable with Schildmacher's work on the redstart, nd, of course, as sexual display is also induced by he presence of sex hormone, it explains the reason or the otherwise incongruous appearance of such display in autumn. Following his detailed study of he British robin, Lack (personal communication) as also arrived independently at a similar interretation of the significance of this autumn sexual display. Because of gonad growth the attachment to the nesting sites, territories, or areas is sustained throughout the entire autumn and winter. At the approach of the breeding season, when gonad growth is greatly accelerated, sexual behaviour merely becomes more diverse and intense, and the connexion with the nesting places is further strengthened and particularized.

W. S. Bullough.

Department of Zoology,
University of Leeds.
April 12.

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[1] Schildmacher, H., *Vogelzug*, 4, 21 (1933).

[2] Bullough, W. S., *Phil. Trans. Roy. Soc.*, B, 231, 165 (1942).

[3] Lack, D., "The Life of the Robin" (in the press).

[4] Morley, A., *Ibis*, 85, 132 (1943).

Innervation of Crustacean Muscles

The physiology of the striated muscle of Crustacea is known to differ in several respects from that of the vertebrates; as, for example, in the peripheral location of the inhibitory process, and the presence of separate motor fibres for slow and fast contractions. The interpretation of these peculiar properties requires a knowledge of the histology of the neuromuscular system, in order to compare and contrast it with the mode of innervation of vertebrate muscle. Van Harraveld[1] has put forward the view that each muscle fibre in the crustacean receives a great many endings from each of the different types of nerve fibre, motor and inhibitory, so that it is surrounded by a dense feltwork of axons, and has forty or more nerve endings on its surface. This view is reminiscent of that of Bethe[2] and Tonner[3], both of whom used a methylene blue staining method to demonstrate an extensive network of nerve axons in crustacean muscle. Unlike van Harraveld, however, they derived this network from a "sub-epithelial nerve plexus", and not directly from the central nervous system. On the other hand, D'Ancona[4], working in Cajal's laboratory, gave a very different histological picture of the peripheral nervous system; he could only demonstrate one or two nerve endings on each nerve fibre, and no nerve network.

As it seems that van Harraveld's histological picture is coming to be generally accepted (see Gerard[5]), it seems desirable to record some preliminary work which led me to consider the possibility that his histological methods have led him to describe as nerve fibres structures which are, in fact, fibrils of connective tissue origin.

In the course of some work on the nervous system of the prawn, *Leander serratus*[6], specimens of the abdominal musculature and whole chelæ of the animal were fixed in various fluids, embedded in wax and cut in serial sections. The nerve axons in the material were stained by Bodian's protargol method.

I found that the protargol method, when applied to material fixed in a saturated solution of picric acid in sea water, demonstrated a fibrous network among the muscles, very similar in appearance to that described by van Harraveld. But in material fixed in a mixture of 80 per cent alcohol, formaldehyde and glacial acetic acid, the method showed no such network, but only a much more sparse system of fibrils, all of which could be traced back to main nerve trunks: no muscle fibre was ever seen to receive more than one or two endings from these nerve axons. Furthermore, I found it possible to stain a fibrous network in this alcohol-fixed material by the use of a silver method which is specific for the reticulin fibrils of vertebrate connective tissue[7]. This network was identical in arrangement with that seen after protargol staining of picric acid material, and its connective tissue nature was demonstrated by its arrangement within the connective tissue sheaths of the main nerve trunks, as well as among the muscle fibres.

Thus a staining method which is specific for nerve axons in vertebrate material, that of Bodian after picric acid fixation, will stain connective tissue fibrils as well as nerve fibrils in Crustacea. It therefore seems likely that van Harraveld's ammoniacal silver method led him to make a similar confusion.

I have not been able to continue with this study since 1939, but the available evidence leads me to believe that the work of D'Ancona gives the most reliable histological picture of crustacean muscle innervation.

William Holmes.

Department of Zoology,
University Museum,
Oxford.
April 15.

[1] van Harraveld, A., *J. Comp. Neur.*, **70**, 267 (1939).
[2] Bethe, A., *Anat. Anz.*, **12**, 31 (1896).
[3] Tonner, F., *Zool. Jahrb. Abt. Phys.*, **53**, 101 (1933).
[4] D'Ancona, U., *Trab. Lab., Madrid*, **23**, 393 (1925).
[5] Gerard, R. W., *Ann. Rev. Physiol.*, **4**, 329 (1942).
[6] Holmes, W., *Phil. Trans. Roy. Soc.*, B, **231**, 293 (1942).
[7] Robb-Smith, A. H. T., *J. Path. Bact.*, **45**, 312 (1937).

Agar from South African Seaweeds

Agar suitable for bacteriological purposes has been extracted from the following species: *Gelidium cartilagineum* (L.) Gaillon, *Gracilaria confervoides* (L.) Grev., *Suhria vittata* (L.) J. Ag.

Of these, *Gelidium cartilagineum* and *Gracilaria confervoides* were previously known sources of agar in other countries: the former in North America and the latter in Ceylon, China, North America and Australia. *Suhria vittata* has long been a source of edible jelly in South African households. This jelly is used in a similar way to that obtained from Irish moss (*Chondrus crispus*).

The various agars prepared were first tested at the Government Low Temperature Research Laboratory, Cape Town, as suitable media for the growth of *Staphylococcus albus*, *S. aureus*, *B. subtilis** and a thermophilic anærobe obtained from blown cans of a meat and vegetable ration. The agars were further tested at the Baragwanath Military Hospital and were found to be suitable media for the growth of *B. coli*, *B. dysenteriæ* Schmitz, *B. dysenteriæ* Flexner, *B. dysenteriæ* Sonne, Staphylococci and Streptococci. A number of the agars prepared, especially those from *Suhria vittata*, proved as good as the best Japanese agars.

Agar was also obtained from *Gelidium pristoides*. This agar was found to be a suitable medium for the growth of the various organisms mentioned above. The agar was, however, of inferior quality. It did not dissolve as easily, the jelly was not as firm (1·5 per cent agar) as the other agars tested, and it was somewhat opaque even after clearing with egg-white.

Preparations for the manufacture of bacteriological agar are well in hand. We are indebted to Mr. P. S. Malan, of Buchanan Ltd., for co-operation in tests relating to the preparation of bacteriological agar on a commercial scale. This aspect of the work has been chiefly concerned with *Gracilaria confervoides*. This species seems to be the most abundant source of agar, since although it is known from only two localities (Hout Bay and Langebaan) it occurs at those places in considerable amounts, especially at Langebaan. Although sub-littoral in habit, it grows in calm water and is rooted in sand. It is washed ashore in very considerable amounts after heavy seas and so harvesting is easy and cheap. A search is being made of additional localities for this species.

The other species listed are also sufficiently abundant on South African coasts to be at least of value as emergency sources of bacteriological agar. Unfortunately the harvesting of *Suhria vittata* in considerable amounts is difficult since it occurs chiefly as an epiphyte on the large kelp *Ecklonia maxima*, which grows in the sub-littoral off the west coast of South Africa. *Gelidium cartilagineum* and *G. pristoides* are chiefly found on the south coast of the Union. The former is uncovered only at low water of spring tides while the latter occurs at about mid-tide level[1].

A low yield of jelly was obtained from *Hypnea spicifera*, J. Ag., which proved to be a suitable medium for *Staphylococcus albus*, *S. aureus* and *B. subtilis*. It is unsuited for work with thermophilic bacteria, however, since it liquefies below 130° F. It has certain physical properties unlike those of agar. As compared with agar, nearly twice as much of the substance is needed to make a jelly.

Wm. Edwyn Isaac.
M. H. Finlayson.
M. Gavine Simon.
Government Low Temperature Research Laboratory,
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Baragwanath Military Hospital Laboratory,
Johannesburg.

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* For standard cultures of the first three species we are indebted to the Department of Bacteriology, Medical School, University of Cape Town.

[1] For details regarding distribution and abundance of the species discussed see Isaac, Wm. Edwyn, *J. South African Bot.*, 225 (1942).

Phagocytosis in the Appendix of the Rabbit

In the recent article "Microbial Factors in the Digestive Assimilation of Starch and Cellulose in Herbivora"[1], attention has been directed to the determinant role taken by iodophile micro-organisms in these processes. During passage through the alimentary canal, the iodophile population is eliminated, and the suggestion has been advanced that in this way the products of microbial synthesis become available to the host animal.

Three factors have been distinguished which may operate to a variable extent in different herbivorou species, namely: (1) action of digestive enzymes o the host animal: (2) ingestion by ciliates of the rume or cæcum; (3) bacterial autolysis.

Reconsideration of some claims advanced by earlie observers has in the meantime indicated that thes factors may be supplemented in certain Herbivor by a true process of endocellular digestion. Thu Bizzozero and Ruffer, as cited by McEwen[2], ha independently described an active phagocytosis o bacteria as occurring in the appendix vermiformis o rabbits. By the use of appropriate histological procedures, we have been able to substantiate this claim

The agents concerned are large mononuclear cells present in great numbers in the lymph nodes and lymph papillæ of the submucosa.

In face of the conflicting views held in regard to the origin of such cells, it is convenient to retain the term macrophage introduced by Metchnikoff[3]. Examination of the macrophages both in organ smears and sections has demonstrated the presence in them, in addition to cell debris, of numerous bacteria. Moreover, the bacteria showed a strong blue reaction on treatment with iodine solution. Since such iodophile species comprise in rabbits[4] the bulk of the microbial population of the cæcum, the origin of the ingested micro-organisms becomes unequivocally clear.

Granulocytes appear to play no part in the observed phagocytosis, which may therefore be attributed to macrophage activity alone. The extent to which this process of endocellular digestion affords an effective contribution to the nutrition of the host animal or is to be regarded merely as a protective mechanism against bacterial infiltration is receiving further attention. The abundant development of lymph nodes in the rabbit's appendix, the numerous macrophages present and the actual size of the organ make it probable that very large numbers of micro-organisms can be dealt with in this way. It must be stressed, however, that this conclusion only refers to the particular herbivorous species under consideration. Thus, for example, in the guinea pig, both appendix and sacculus are lacking, the lymph nodes being confined to the small agminate glands distributed at intervals along the margin of the cæcum.

Again, in the human appendix itself, the development of the lymph nodes is, in comparison with the appendix of the rabbit, very restricted, and examination of smears and sections has revealed no clear evidence of macrophage activity.

In regard to the musculature of the wall, however, a contrasting situation is disclosed, a fact of interest in view of the role that has sometimes[2] been attributed to the human appendix in the regulation of colonic peristalsis. These considerations, among others, indicate that the functional significance of the appendix may vary in different animal species, devolving both on the general organization of the alimentary canal, and the characteristics of the microbial population[1,5,6] which it supports.

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JOHN ENTICKNAP.

County Technical College,
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April 2.

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Frictional Properties of Metallic Films

A RECENT communication by Schnurmann[1] has riticized the interpretation of earlier observations[2] on the frictional behaviour of thin films of soft metals on a copper surface made on the Bowden-Leben pparatus.

It is not an uncommon experience in frictional studies to find difficulty in correlating the results obtained on different machines. Factors, such as the rate of repair of lubricant films, surface oxidation and other contamination, frictional heating, and many others, may be of great importance and lead to discrepancies. In the absence, therefore, of a detailed account of Dr. Schnurmann's experimental method, it is not possible to attempt to interpret his observations in the light of earlier published work on the Bowden-Leben apparatus. It is obvious, however, that there is a wide difference between conditions in the type of machine he refers to and those in the Bowden-Leben machine. Dr. Schnurmann has measured the friction of a loaded steel ball rotating on a steel plate, under which conditions the ball presumably must rotate in one spot or around the same track. Since he finds that films of soft metals wiped on to the steel sliding surfaces do not decrease the friction, he implies that the earlier published work carried out on the Bowden-Leben machine, which uses quite different conditions and materials, was incorrectly interpreted.

The work to which Dr. Schnurmann refers dealt with frictional measurements using a hemispherical steel slider moving slowly over films of soft and low melting-point metals (lead, tin and cadmium) rubbed on to copper surfaces. Under these conditions the coefficient of friction was reduced considerably below the values for either metal separately, often to surprisingly low values; for example, $\mu = 0{\cdot}03$ for lead films. The view was taken that this decrease in friction coefficient resulted from the decrease in adhesive forces across the small area of contact, rather than from any reduction in the ploughing forces, that is, the forces involved in producing a groove in the lower surface. In actual practice, it may often be difficult to distinguish purely grooving effects from changes in the forces of adhesion accompanying the removal or deposition of contaminant films on the lower or upper surfaces, which take place during successive slides in the same track. However, Bowden, Moore and Tabor[3] have recently evaluated the approximate contributions of adhesion and ploughing forces to the friction of steel on indium. Even with such a soft metal as indium, the adhesion term for hemispherical sliders was shown to be roughly twice as large as the ploughing term. Unfortunately, such a quantitative treatment has not been carried out on the lead-copper alloys. However, there were mentioned in the original communication[2], and also in an earlier one[4], a few simple experimental observations which showed clearly that grooving effects were always small compared with the magnitude of the frictional changes accompanying the deposition and removal of surface films of various materials on copper, including films of lead, tin and cadmium. These will be briefly summarized:

(*a*) The frictional decreases due to these metal films were observed during the *first* slide, and the friction remained little changed by successive slides in the same track. Eventually, continued sliding in the same track penetrated the soft metal film and the friction *rose* to values approaching that for steel on copper. If these effects were due to changes in the ploughing or grooving contributions to the frictional forces, as Dr. Schnurmann appears to suggest, then one would expect to find a markedly higher frictional resistance during the initial slide in any track, and certainly no rise on further sliding in the same groove.

(*b*) The *increase* in friction accompanying the removal of the soft metal film in the groove, say, lead on copper, was easily demonstrated by addition of oleic acid or even oxidized oil to the surfaces, when the friction became greater instead of less, or by wiping with dilute caustic soda solution. Such changes in the friction, due to the removal of the films of soft metal, varied in magnitude with the metals considered, but appeared to account for the greater part of the overall effect. They clearly illustrate that the grooving contribution to the friction, which must evidently be present to a certain extent, is small compared with the contribution of adhesive forces to the total friction.

Dr. Schnurmann seems to have misrepresented the results listed in Table 2 (ref. 2). The frictional data were intended to show that, while the value of μ was 0·3 for a steel hemisphere sliding very slowly on a lead-copper bearing alloy at 20° C. (even after a number of slides in the same track), μ became reduced to 0·08 after a number of slides in the same track at 100° C. This low value of μ in the same track remained unchanged on cooling. Since the reduction in μ brought about by sliding at high temperatures was to a much lower value than could be associated with grooving effects based on changes in mechanical properties, it was therefore considered to result from the wiping-out of the soft phase (lead) over the hard phase (copper). This was further supported by the previous data on the frictional properties of copper covered with a known lead film. In addition, removal of the lead film restored the low value of μ to near its initial value.

It was mentioned in the original communication[2] that if the film of soft metal was deposited on a hard backing, the film was easily broken through and little reduction in the value of μ below that of the unplated metal would result. It is therefore not at all surprising that Dr. Schnurmann found no decrease in the friction of a steel sphere rotating (presumably in the same area or track) on a steel flat initially plated with a soft metal. The soft metal would be wiped away and penetrated very rapidly under such high loads at the point of contact.

A certain amount of work (as yet unpublished) has been done on soft metal films on various metals at speeds up to 250 cm./sec., and in general the results bear out those obtained on the Bowden-Leben apparatus. However, the film of soft metal may have a short life for continued dry sliding in the same track or groove. In practice, in an actual bearing, the value of the soft metal phase may lie in its ability to prevent local seizures for short periods of time when the lubricant film happens to become penetrated in some way.

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Public Appreciation of Science

As a man in the street with no claim to be a scientist I read with interest the report in NATURE of April 3 of the conference convened by the British Association to consider ways and means for increasing public appreciation and understanding of science. The impression I gain from this and similar discussions is of a disposition to blame various forces extraneous to the scientific community for the failure of science to exert upon the public mind the influence which it should. So far as Great Britain is concerned, however, I suggest that a chief responsibility for the frustration of science, so far as it is determined by public ignorance, rests primarily on scientific men themselves.

In the United States of America they do things better. Science Service has been operating since 1921, and is now conducted by the Institution for the Popularization of Science. This is a non-profit corporation controlled by a Board of Trustees nominated by the chief scientific and technological organizations in the United States. It is a model, showing what scientific men can do when they cease blaming other people and open the doors which are already swinging on their hinges. In its weekly Science News Letter, the Institute turns out an up-to-date picture of the contemporary progress of science and technology. It has initiated, all over America, Science Clubs where the vast undeveloped potentialities of scientific curiosity and creativeness of the common person, and particularly of youth, is provided with opportunity and guidance. In its Things of Science service it makes available at low cost specimens of the new materials which science is bringing into being as the fabric of an emerging civilization. Through its annual Science Talent Search it is combing out the potential genius of American boys and girls and providing, in conjunction with the Westinghouse Corporation, scholarships to enable the potential Edisons and Faradays of the coming decades to develop what is in them. All this may be well known. British scientific people have nothing similar.

I write as an individual entitled to speak for nobody but myself and therefore with the greater freedom. To my unsubtle mind it seems that if British men of science really believed in science for the service of mankind and acted upon that belief, they would brush aside in this connexion the irrelevant political dividing lines which segregate the English-speaking peoples. Why, in short, should not British science organizations forthwith become affiliated with the American Institute for the Popularization of Science, receiving appropriate representation on its Board of Trustees, publishing a British edition of Science News Letter and organizing, as opportunities allow, the democratic facilities and opportunities which are indispensable in order that the new generations shall be equipped with the temper and technique of science.

The fundamental need of our age, as Mr. Wells has so magnificently shown, is synthesis of all the forces, political, economic, intellectual and moral, of the inhabitants of our planet. The temper, technique and aspirations of science are bound up inescapably with the idea of mankind as one community. If scientific men cannot unite, even where the barriers of language do not exist, to whom shall we turn to give a lead ?

Why should not scientific men of the Atlantic democracies mobilize in one organization now, to lay the intellectual and moral foundations of the new order which is the only alternative to misery, frustration, disaster ? Surely for every reason against, there are a hundred for.

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ESTIMATION OF VITAMIN A

THE second International Conference on Vitamin Standardisation provisionally fixed 1,600 as the value for the factor relating the results of spectrophotometric tests of vitamin A with the results of biological tests, expressed in international units.

In 1935 and 1937 the Vitamin A Sub-committee organized co-operative tests to make further determinations of the value of this factor[1,2]. The materials tested were a specimen of halibut liver oil, a concentrate derived from it, and the United States Pharmacopœia reference cod liver oil. The concentrate yielded a conversion factor of between 1,000 and 1,200; but it was unstable, and the deterioration was sufficient to account for the lowness of the value. The value of the conversion factor for the halibut liver oil was originally calculated to be 1,470[1] but later, at the time of the experiment on the U.S.P. reference oil, it was recalculated by improved statistical methods, and the values for the halibut liver oil and reference oil were then found to be 1,570 and 1,820, respectively. Since the difference between the logarithms of these two values was 2·1 times its standard error, the odds were about 30 to 1 against that difference being due to chance. As a result of these experiments, the recommendation was made to retain the provisional value of 1,600 as the best compromise and to await further data.

In 1939 it was planned to hold a third meeting of the International Standardisation Conference towards the end of the year, with the question of the value for the conversion factor as part of the agenda. The Vitamin A Sub-committee, as a further contribution to the settling of this difficult and practically very important problem, decided to make a co-operative test, similar to the two preceding ones, on one of the pure esters of vitamin A recently prepared in the laboratories of British Drug Houses, Ltd., by Mead[3]. The β-naphthoate, first described by Hamano[4], was selected and was placed at the disposal of the Vitamin A Sub-committee by the kindness of the British Drug Houses, Ltd., on behalf of whom Dr. T. H. Mead gave invaluable help in the preparation of a suitable and stable solution for feeding in the biological tests.

The experiment was planned on the same lines as the two preceding ones, being in its essence a comparison of the vitamin A potency of vitamin A β-naphthoate and of international standard β-carotene in biological tests with rats, spectrophotometric estimations being made at the end, as well as at the beginning, of the feeding tests, so that the stability of the test solutions could be controlled throughout. The biological tests were carried out in almost the same set of laboratories as before and the spectrophotometric tests were in the hands of Dr. R. A. Morton. A special dilution of the international β-carotene standard was prepared as before by the Department of Biological Standards at the National Institute for Medical Research.

The projected third meeting of the International Vitamin Standardisation Conference in 1939 could not take place, but the tests went on and were completed, not without difficulty, by most of the participants. The collected individual results were placed in the hands of Dr. J. O. Irwin who, besides working out the combined result, has made use of the material of this and the two preceding experiments for an exhaustive study of the accuracy of the biological test for vitamin A; it is hoped to publish this study shortly.

For the solution of vitamin A β-naphthoate used, the value obtained for $E^{1\text{ per cent}}_{1\text{ cm.}}$ 325 mμ was 0·094*. Nine laboratories sent in results of biological tests. They ranged from 97 to 260 I.U. per gm. of the naphthoate solution. The weighted mean of the results, derived in all cases from tests of five weeks duration, was 166 I.U. per gm. The limits of error for this result ($P = 0{\cdot}99$) were 89–112 per cent. The conversion factor for this experiment is, therefore, $166 \div 0{\cdot}094 = 1770$, and lies between the values 1,570 and 1,820 obtained in the two previous experiments. The difference between the two extremes seemed earlier to be significant but, after inclusion of the most recent data leading to an intermediate value, it was concluded from consideration of the logarithms of the three values and of their standard errors that the three values did not differ significantly. This being the case, it is permissible to pool the results, and obtain a conversion factor of 1,740, with limits of error ($P = 0{\cdot}99$) of 93–107 per cent.

Practical application of such a conversion factor to commercial oils and concentrates is, of course, conditional on the absence or elimination of irrelevant absorption at 325 mμ. This matter has been discussed by Morton[5]. It would appear that a single factor is still justified for all spectroscopically normal vitamin A preparations, oils or concentrates.

The very consistent evidence obtained in the United States for a conversion factor of 2,000 or more is most probably to be explained by the wide use of the U.S.P. reference cod liver oil as standard of reference, while in Great Britain the international standard preparation of β-carotene has been more generally used. The U.S.P. reference oil has always officially borne the value of 3,000 I.U. per gm., which was the value found in exhaustive tests against the 1931 mixed carotene standard. In the co-operative test carried out by the Vitamin A Sub-committee on this oil, comparison was made with the 1934 pure β-carotene standard, and the value found was 2,619 instead of 3,000 I.U. per gm. This discrepancy between the reputed value for the U.S.P. reference oil and that found in a test against pure β-carotene corresponds closely with the difference between the value for the conversion factor of 2,000 preferred in the United States and that of 1,740 found by the Vitamin A Sub-committee.

To what extent the discrepancy between the values of 2,619 and 3,000 I.U. per gm. for the U.S.P. reference oil arose through use of the imperfectly related 1931 and 1934 carotene international standards or through deterioration, for which there is spectroscopic evidence, cannot now be determined, nor is it important to do so. What is important is to find some satisfactory solution to the difficulty which has arisen from the use of two different conversion factors on

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*The vitamin A β-naphthoate showed:

$E^{1\text{ per cent}}_{1\text{ cm.}}$	693 mμ	167 (vitamin A_2 in small amount)	
	617 mμ	3804	
	325 mμ	1200	(cyclohexane)
	(corr'd.)	1180	

and the solution in arachis oil was 0·00902 per cent wt./wt. or 0·0083 per cent wt./vol. The expected value for $E^{1\text{ per cent}}_{1\text{ cm.}}$ 325 mμ was, therefore, 0·098. The observed value was 0·094 with the undiluted arachis oil solution (1 mm.) and 0·105 with a 10 per cent solution in cyclohexane (1 cm.). The effect of the solvent on the *E* values makes an unfortunate complication and, if no destruction of vitamin A β-naphthoate occurred, a good case could be made out for $166/0{\cdot}098 = 1694$ as against 1740. There is, however, not much to choose between the alternatives when the various sources of error are taken into account.

the two sides of the Atlantic. After the International Conference of 1934 it was accepted by the U.S. Pharmacopœia Commission that the U.S.P. unit should have the same value as the international unit, 3,000 of each being contained in one gram of the U.S.P. reference cod liver oil. As has been shown above, the U.S.P. reference oil does not, in fact, contain as many as 3,000 I.U. per gm. The simplest solution would, therefore, appear to be to recognize that the U.S.P. and international units have not, after all, the same magnitude, but that the former is only 2,619/3,000 or about 7/8 of the latter and that the respective conversion factors are about 2,000 and about 1,740.

This solution would leave the literature in some confusion, since the U.S.P. unit and the international unit have been regarded since the 1934 Conference as identical in value, and the terms as interchangeable, but the confusion does in any event exist and its existence is better recognized. In most of the work in which the confusion occurs, the magnitude of the discrepancy is not large enough to matter very much from the practical point of view. In connexion with commercial transactions where it is large enough to be important financially, agreement is in practice reached on the basis of concordant spectrophotometric determinations, but it is desirable that the exact nature and magnitude of this discrepancy should be recognized, and the position reviewed as evidence accumulates.

Those who took part in the work were: A. L. Bacharach, Glaxo Laboratories, Ltd., Greenford; W. A. Broom, Messrs. Boots Pure Drug Co., Ltd., Nottingham; H. M. Bruce and K. H. Coward, Pharmaceutical Society, London; A. D. Emmett and R. D. Brown, Messrs. Parke, Davis and Co., Detroit Laboratories (communicated by J. A. Freeman); E. M. Hume, Lister Institute, London; J. O. Irwin, London School of Hygiene and Tropical Medicine; T. H. Mead and S. W. F. Underhill, Messrs. The British Drug Houses, Ltd., London; T. Moore, Dunn Nutritional Laboratory, Cambridge; R. A. Morton, University, Liverpool; W. Stott, British Cod Liver Oil Producers (Hull), Ltd.: H. Wilkinson, Lever Bros. and Unilever, Ltd., Port Sunlight.

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CARNEGIE CORPORATION OF NEW YORK

THE report of the Carnegie Corporation of New York for the year ending September 30, 1942, includes the report of the president, that of the secretary, with a list of appropriations authorized during the year, and the report of the treasurer.

In his first report as president, Mr. W. A. Jessup contrasts the present programme of the Corporation with that carried on during the War of 1914–18. During that War, the Carnegie Corporation was scarcely more than an institutionalized extension of Mr. Carnegie's personal philanthropy. Its administrative machinery was new and its programme still in the making. Its direct contribution to the War took the form of generous gifts to outstanding private agencies which had undertaken to supply the amenities of life in the army camps. Appropriations to other Carnegie enterprises more actively concerned in the war effort and to the National Research Council were also voted.

Since 1918 the Corporation has granted 140,800,000 dollars to various agencies and institutions which share its concern for the advancement and diffusion of knowledge, many of which are now in a position to render direct and useful services to the Government of the United States. Secondly, the public has been educated to support the social service agencies which were the chief recipients of grants made during 1917–18, and these agencies no longer look to the Corporation for any substantial proportion of their operating income. Moreover, the present War now involves the mobilization of the whole of the nation's intelligence, and under such conditions the Corporation, owing to its peculiarly close relations with men of science and scholars, can play a useful part within the terms of established policies.

Of the grants voted during the year 1941–42 totalling 2,831,650 dollars, 536,565 dollars have been given for activities directly related to the War. Of the new grants, the largest, 100,000 dollars, has enabled the Joint Army and Navy Committee on Welfare and Recreation to conduct experimental programmes as a basis for the growing activity of the Special Service Division of the War Department. Donations amounting to 12,500 dollars were made to the American Council of Education to keep colleges and universities informed of the needs in personnel of defence agencies and conversely to inform these agencies of the man-power resources of educational institutions. The three major grants to educational institutions during the year were to the new University Centre in Atalanta, the Johns Hopkins University in Baltimore and the New York University. A grant of 10,000 dollars was voted for the formulation of special tests to be used in selecting personnel to be trained under the defence-training programme of the United States Office of Education. To prevent the curtailment of the services of the New York Academy of Medicine, an appropriation of 150,000 dollars was made to the Academy. Substantial endowment grants made to the National Academy of Sciences in earlier years have freed its operating arm the National Research Council, from dependence on term grants, but in view of its new responsibilities the Trustees have voted a sum of 25,000 dollars to the National Academy in addition to the revolving fund of 100,000 dollars appropriated the preceding year.

Grants in support of the Social Science Research Council and the American Council of Learned Societies have also been renewed. These Councils have been the mainstay of the Government in staffing new defence bureaux and in prosecuting research to forward the war effort. The American Council on Education has served as a liaison agent between the Government and education, and the Social Science Research Council has assisted in the preliminary work on the national roster of specialized personnel and is serving as an advisor to the Government on many problems within the field of social science. On the other hand, the activities of the Committee on Scientific Aids to Learning have had to be suspended, and its director has been loaned to the Office of Scientific Research and Development, which is assuming much of the burden carried by the National Research Council during 1917–18. In view of the uncertainty now prevailing in world conditions, total appropriations from the British Dominions and Colonies Fund were less than in any year since 1927.

The report also includes a review of the contributions of the Corporation to the development of public and academic libraries and an analysis of a summary of the total grants made by the Corporation since 1911. Of this total of 185,000,000 dollars, 70,000,000 dollars were made to agencies or enterprises established by Mr. Carnegie himself or growing immediately from them ; 48,000,000 dollars to 848 universities, colleges and schools ; 50,000,000 dollars to 777 associations, museums, libraries and agencies for research and study. More than 60 per cent of this 50 million dollars went to 22 agencies, particularly the National Academy of Sciences, including the National Research Council and the Committee on Scientific Aids to Learning (8,005,678 dollars), American Library Association (3,373,050 dollars), New York Academy of Medicine (1,625,190 dollars), American Council of Learned Societies (595,550 dollars) and Institute of International Education (1,354,979 dollars).

MEASUREMENT OF LIGHTNING

IN an article on the measurement of lightning in relation to telephone cables (*Bell Lab. Rec.*, 21, No. 4 ; Dec. 1942), J. J. Mahoney, jun., describes some simple forms of apparatus used to ascertain the magnitude of lightning surges striking selected or other structures.

In a lightning-prone area, near Lakewood, New Jersey, a number of steel masts were connected to about four miles of cable, buried for lightning tests in 1939 and not connected in any way to the Bell System plant. A tall steel mast is attached to the top of a wooden pole to direct lightning to buried telephone cables. The lightning current is conducted over a wire to an adjacent shorter pole on which measuring equipment is installed.

The tests include measurements of the crest value of the lightning current entering the cables, steepness of the wave front, the quantity of electricity in the lightning surge and the crest voltage across the insulation of the buried cable conductors. When plant damage occurs, an attempt is made to correlate t with the characteristics of the observed stroke. The ability of bare copper wires of various sizes to carry lightning current is being studied incidentally.

Since months may pass before a stroke is observed, simple inexpensive devices must be used. Their ecord is in the permanent magnetism given to them by the lightning. In one form, the magnetic links are traight pieces of laminated iron, each about 1½ in. ong, enclosed in a Bakelite shell, mounted so as to ntercept a magnetic field of greater or less strength, epending on their distance from the conductor, nd so record currents from 500 to 10,000 amp. The links are calibrated in advance by determining the ntensity of magnetization given to them by known urrents.

The wave front steepness of a lightning surge is ascertained by inserting a magnetic link in a coil which is coupled with the lightning conductor. The apparatus has a rectangular loop of wire, one side of which is wound as a solenoid to enclose the link. When mounted a short distance from a conductor carrying a lightning surge, the link becomes magnetized and measures the peak current in the test circuit. From this and the crest value of the current in the lightning conductor, the time when the crest value of the discharge current is reached can be calculated from the resistive and inductive constants of the test circuit. Three loops are usually used at different distances from the conductor in order to increase accuracy of measurement.

The electrical charge of a lightning stroke is found by connecting a resistance in series with the lightning conductor and shunting an inductance across the resistance. The crest value of current in the inductance is measured by a magnetic link, and the charge then calculated from the product of the current and the inductance divided by the resistance. Peak voltages produced in telephone conductors by lightning are measured by a klydonograph, which consists of a blunt electrode in contact with the emulsion of a photographic plate backed with sheet metal and protected by a light-tight housing. The approximate magnitude and the polarity of the applied voltage can be determined by the size and appearance of the figure appearing on the developed plate. To measure the ability of lightning current to fuse bare copper wires of different gauges, several short lengths are connected in series on a terminal strip and inserted in the lead from each mast. Arcs between the ends of bent wires carry the discharge past test wires which have fused.

All the instruments used are simple to install, inexpensive and require no attention except that they are checked after each lightning storm by bringing a pocket compass near the links to test them for magnetism. Those found magnetized are removed for more accurate tests, and the photographic plates of the voltage recorders in the circuits affected are developed. The cable conductors are checked at the same time to detect plant damage.

Of three lightning strokes which have hit this experimental plant, only one struck a mast and splintered it slightly. This occurred in July 1939, before the buried cable and measuring equipment were installed. The second stroke came in October of the same year, striking a tree and entering a test cable near it by arcing from the tree's roots. The nearest measuring equipment, approximately 500 ft. away, recorded a crest current of 12,000 amp. The cable was considerably damaged. A third stroke occurred in July 1941. It also hit a tree and the lightning current entered the same cable through tree roots. Peak currents from this stroke varied from about 1,600 to 11,000 amp. at different points of the installation. Voltages ranged from 2 to 10 kV. and the quantity of electricity from 1 to 4 coulombs. Surge recorders showed that the time from start to crest of the discharge was 16 µsec. Bare copper wires of 24 and 28 gauge fused on the poles nearest the tree hit. A steel culvert conducted current to the cable buried north of the road. The cable which was struck was about ½ in. in diameter, including its lead sheath, and was enclosed in a vulcanized rubber covering about 1/16 in. thick. Small puncture marks were found in the rubber where the lightning current entered the sheath. No other damage was found.

FORTHCOMING EVENTS

(* *Meeting marked with an asterisk is open to the public.*)

Monday, May 10

ROYAL GEOGRAPHICAL SOCIETY (at Exhibition Road, London, S.W.7), at 8 p.m.—Sir Percy Loraine: "Perspectives of the Near East".

Tuesday, May 11

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—K. de B. Codrington: "Afghanistan Today".

ILLUMINATING ENGINEERING SOCIETY (at Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 4.30 p.m. Annual General Meeting.—Sir John Parsons: "Light and Vision".

ROYAL PHOTOGRAPHIC SOCIETY: SCIENTIFIC AND TECHNICAL GROUP, (at 16 Princes Gate, London, S.W.7), at 5.0 p.m.—Dr. G. Spiegler: "Contrast and Definition on X-Ray Pictures (in Relation to General Photography)".

Wednesday, May 12

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. Marion Delf: "The Nature and Uses of Seaweeds".

PHYSICAL SOCIETY: COLOUR GROUP (at the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Mr. G. S. Fawcett (Tintometer, Ltd.): "Sixty Years of Colorimetry".

Thursday, May 13

TOWN AND COUNTRY PLANNING ASSOCIATION (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Dr. Dudley Stamp: "Reconstruction and Country Life".

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 2.45 p.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

Friday, May 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, London, W.1), at 4.30 p.m.—Prof. H. Dingle: "Copernicus".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m. Sir George Stapledon, C.B.E., F.R.S.: "Grassland and Modern Farming".

ASSOCIATION OF SCIENTIFIC WORKERS (HARPENDEN BRANCH) (at Harpenden Congregational Church Hall), at 5 p.m.—"World Agriculture and Man's Nutritional Needs, 4." Sir John Russell, F.R.S.: "Agriculture in Relation to Nutritional Demands".*

Saturday, May 15

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. O. Godart: "Belgian Scientists and the War".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MEN with a sound practical knowledge of MODERN CROP HUSBANDRY and FARM ROUTINE able to arrange and carry out demonstrations on farms, Devon County War Agricultural Executive Committee—Executive Officer, Bradninch Hall, Exeter (May 15).

An ASSISTANT SECRETARY to the Norfolk War Agricultural Executive Committee—Secretary, Sprowston, Norwich (May 22).

(1) TWO TECHNICAL OFFICERS, with technical and practical knowledge of AGRICULTURE, to work under the direction of the Technical Development Sub-Committee; (2) TWO DISTRICT OFFICERS, with a practical knowledge of AGRICULTURE, to work under the direction of the Executive Committee; (3) an ASSISTANT PESTS OFFICER, County of the Isle of Ely War Agricultural Executive Committee—Executive Officer, Marcam House, March (May 24).

(1) METALLURGICAL CHEMIST for light alloy foundry, with experience of works technical control and if possible of pyrometry; (2) WOMAN ANALYTICAL CHEMIST, if possible with experience of light alloys; (3) METALLURGIST with some experience of non-ferrous work, H.T. furnaces and producer gas plant, for an aircraft factory, South Wales—Appointments Office, 26 High Street, Cardiff.

Retired professional man or woman required as Temporary (full-time) LIBRARIAN by Royal Society of Arts for purpose of compiling a catalogue of approximately 3,000 books—Acting Secretary, 6–8 John Adam Street, London, W.C.2.

LECTURER IN CHEMISTRY (temporary) for the Military College of Science—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2, quoting Ref. O.N.F. 1079.

BIOCHEMICAL ASSISTANT for Hospital Laboratory with University Degree with Chemistry or Biochemistry as a principal subject, at the Royal Sussex County Hospital, Brighton—Pathologist, Royal Sussex County Hospital, Brighton, 7.

A TEMPORARY FULL-TIME TEACHER (man) of PHYSICS and CHEMISTRY (graduate) for teaching duties and to take charge under the Acting Principal, of the Science and Technical division of the Norwood Technical Institute, Knights Hill, S.E.27—Education Officer, T.1, The County Hall, Westminster Bridge, S.E.1, with stamped addressed foolscap envelope.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research: Forest Product
Research Laboratory. A Handbook of Empire Timbers. (War Emer
gency Supplement.) Edited by H. A. Cox. Pp. 42. (London: H.M
Stationery Office.) 9*d*. net. [5

Proceedings of the Royal Irish Academy. Vol. 49, Section B, No
2: The Distribution and Origin of the British Lepidoptera. By D
Bryan P. Beirne. Pp. 27–60. (Dublin: Hodges, Figgis and Co., Ltd.
London: Williams and Norgate, Ltd.) 2*s*. [5

Proceedings of the Royal Society of Edinburgh. Section A (Mathe
matical and Physical Sciences). Vol. 61, Part 3, No. 22: Some Applica
tions of Marcel Riesz's Integrals of Fractional Order. By E. T
Copson. Pp. 260–272. (Edinburgh and London: Oliver and Boyd
1*s*. [5

The Colonies: the Labour Party's Post-War Policy for the Africa
and Pacific Colonies. Pp. 24. (London: The Labour Party.) 3*d*. [9

South-West Essex Technical College and School of Art. Annua
Report, Session 1941–42. Pp. 32+4 plates. (London: South-Wes
Essex Technical College and School of Art, Walthamstow.) [9

The Welding of Cast Iron: a Review. By J. G. Pearce. (T.9.) P
22. (London: Institute of Welding.) 2*s*. [9

Report on a Preliminary Investigation of the Welding of Cast Iro
By W. J. Driscoll. (R.19.) Pp. 10. (London: Institute of Welding
2*s*. 6*d*. [9

Proceedings of the Royal Irish Academy. Vol. 48, Section B, N
12: Salmon of the River Corrib, together with Notes on the Growt
of Brown Trout in the Corrib System. By Arthur E. J. Went. P
269–298+plate 2. (Dublin: Hodges, Figgis and Co., Ltd. London
Williams and Norgate, Ltd.) 2*s*. [12

Other Countries

Smithsonian Institution: Bureau of American Ethnology. Bulleti
132: Source Material on the History and Ethnology of the Cadd
Indians. By John R. Swanton. Pp. vii+332+19 plates. (Wash
ington, D.C.: Government Printing Office.) 75 cents. [5

Smithsonian Institution: United States National Museum. Repo
on the Progress and Condition of the United States National Museu
for the Year ended June 30, 1942. Pp. iii+118. (Washington, D.C.
Government Printing Office.) 20 cents. [5

Department of Agriculture, Fiji. Bulletin No. 22: An Introductio
to the Mosquitoes of Fiji; Descriptive Notes on the Commoner Specie
their Breeding Places and Occurrence, together with Simplified Key
for Distinguishing the Adults and Larvae of Fijian Mosquitoes. B
R. W. Paine. Second edition. Pp. 35. (Suva: Department of Agr
culture.) [5

Bernice P. Bishop Museum. Bulletin 172: Insects of Guam,
Pp. v+218+10 plates. Bulletin 173: The Genus Nysius and i
Allies in the Hawaiian Islands (Hemiptera, Lygaeidae, Oroillini). B
Robert Leslie Usinger. Pp. ii+168+12 plates. Bulletin 175: Repo
of the Director for 1941. By Peter H. Buck (Te Rangi Hiroa). P
ii+20. Bulletin 176: Shallow-water Asteroidea and Ophiuroidea
Hawaii. By Charles A. Ely. Pp. ii+64+13 plates. (Honolulu
Bernice P. Bishop Museum.) [7

Occasional Papers of the Bernice P. Bishop Museum. Vol. 1
No. 14: Mosses collected by Hawaiian Bog Survey of 1938. B
Edwin B. Bartram. Pp. 321–336. Vol. 16, No. 17: Hawaiian Belie
and Customs during Birth, Infancy and Childhood. By Mary Kawen
Pukui. Pp. 357–382. Vol. 17, No. 1: Polynesian Spiders. By Lucie
Berland. Pp. 24. Vol. 17, No. 2: Lichens of Nihoa and Necke
Islands. By A. H. Magnusson. Pp. 25–42. Vol. 17, No. 3: Pycnogonid
from Hawaii. By William A. Hilton. Pp. 43–56. Vol. 17, No. 4
Shell Fishhooks of the California Coast. By Eugene Robinson. P
57–66. Vol. 17, No. 5: A New Hawaiian Panicum (Gramineae). B
Edward Y. Hosaka. Pp. 67–70. Vol. 17, No. 6: Psyllidae from Rap
the Caroline, Society, and Austral Islands (Homoptera). By Leonard
Tuthill. Pp. 71–78. Vol. 17, No. 7: New Combinations in the Gleic
eniaceae and in Styphelia (Epacridaceae). By Harold St. Joh
(Pacific Plant Studies, 1.) Pp. 79–84. Vol. 17, No. 8: New Caledonia
Microcryptorhynchus (Coleoptera, Curculionidae). By Elwood
Zimmerman. Pp. 85–90. Vol. 17, No. 9: Notes on Fijian Land Snail
By C. Montague Cooke, Jr. Pp. 91–96. Vol. 17, No. 10: Teredinid
of Hawaii. By Charles Howard Edmondson. Pp. 97–150. (Honolul
Bernice P. Bishop Museum.) [

Imperial College of Tropical Agriculture: Department of Mycolog
and Bacteriology. Memoir No. 7: Studies in the Witches' Broo
Disease of Cacao caused by *Marasmius perniciosus* Stahel. Part
Introduction, Symptoms and Etiology. By R. E. D. Baker and S.
Crowdy. Pp. 28+18 plates. (Trinidad: Imperial College of Tropic
Agriculture.) [

Department of Science and Agriculture, Jamaica. Bulletin No.
(New Series): A Survey of the Yields of Sugar Cane in Jamaica, 194
1941. By R. F. Innes. Pp. 31. (Kingston: Government Printi
Office.) 6*d*. [1

Jamaica. Annual Report of the Department of Agriculture for t
Year ended 31st March 1942. Pp. 18. (Kingston: Governme
Printing Office.) [1

U.S. Department of Agriculture. Technical Bulletin No. 80
Biology of the Narcissus Bulb Fly in the Pacific Northwest. By Charl
F. Doucette, Randall Latta, Charles H. Martin and Ralph Scho
and Paul M. Eide. Pp. 67. Technical Bulletin No. 816: Life Histor
Habits and Control of the Beanstalk Weevil (*Sternechus paludat*
in the Estancia Valley, New Mexico. By J. G. Shaw and J. R. Douglas
Pp. 36. (Washington, D.C.: Government Printing Office.) [1

Scientific Reports of the Imperial Agricultural Research Institut
New Delhi, for the Year ending 30th June, 1941. Pp. ii+73. (Delh
Manager of Publications.) 1·8 rupees; 2*s*. 3*d*. [1

NATURE

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POST-WAR AGRICULTURAL EDUCATION

NEARLY two years ago the Minister of Agriculture appointed a committee under the chairmanship of Lord Justice Luxmoore to examine the present system of agricultural education in England and Wales and to make recommendations for improving and developing it after the War. Both the need and the magnitude of the task are evident from that Committee's report, which has now been issued*. The Committee interpreted 'agricultural education' as covering the bringing up, training and instruction of adolescents and adults in the sciences applicable to agriculture; the art and practice of the various branches of animal and crop husbandry, including horticulture; the provision of advisory services and the organization of general instructional work by means of lectures and demonstrations.

So long ago as 1668 Abraham Cowley directed attention to the neglect by landowners in not providing suitable tutors for their children to instruct them in the nature and improvements of the land they would inherit. He suggested that one college in each university should be erected for the study of agriculture. It was not until 220 years later that the first university college provided facilities for the study of agriculture, though the Royal Agricultural College was established in 1845. The early days of organized agricultural education were more directly associated with the other cultural branches of education than has been the case more recently, being fostered by the Board of Education through the activities of the local education authorities. Many of the ideas which now prevail concerning 'rural bias' were appreciated in the early years of the present century. It is a singular fact, however, that farmers themselves have long held the idea that education of any kind produced an attitude of mind inimical to manual work, whereas in point of fact it is largely an economic one.

Since 1911 the Board (now Ministry) of Agriculture has been the prime mover in matters affecting agricultural education, operating through grants to local education authorities in the counties and to the governing bodies of universities and colleges. This has resulted in considerable developments and in some cases notable results have been achieved, but invariably in proportion to the means available for the purpose. Unfortunately the application of schemes for advancing agricultural education has been very uneven in character, due in a large measure to unsatisfactory methods of rendering financial aid and the lack of authority in regard to development work.

The present War had not been long in progress when it was realized that food is a vital munition. The agricultural education staffs in the counties were diverted to the direct task of organizing the food production effort. Considerable powers were entrusted to the War Agricultural Executive Committees, but it is of more than ordinary interest that it is being recognized increasingly by farmers and their workers that an intensification of educational work is the quickest way of making progress. It is no longer necessary to convince the average farmer that practice by itself will not reach the goal of maximum efficiency. The ideal is that combination of 'practice with science' which was adopted as the motto of the Royal Agricultural Society of England so long ago as 1840. Into this happy atmosphere the Luxmoore Report has been born.

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* Report of the Committee on Post-war Agricultural Education (Cmd. 6433.) Pp. 92. (London: H.M. Stationery Office, 1943.) 1s. 6d. net.

As a record of the position obtaining at the present time the Report is valuable. Attention is directed to past and present weaknesses. It is perhaps unfortunate that the background of war-time needs and methods has largely affected the trend of ideas, and it is by no means certain that these views will obtain for any length of time on the conclusion of hostilities. It becomes necessary to stress this fact, for though inquests are very necessary, it is by no means true that the pre-war agricultural education system of Great Britain was so completely moribund that only a revolutionary replacement of the old system can achieve results which everyone wishes to see realized. The absence of uniformity is not necessarily a defect. It is one of the strong features of democratic government. In fact, one may go so far as to say that uniformity in any branch of college or university education is undesirable. In agricultural education, however, where the need has been greatest the means for rectifying this position have been totally inadequate.

It is accepted as a preliminary necessity that agriculture should be made sufficiently attractive to induce young people to enter it. A solid foundation of general education is stressed. A prevailing tendency in some agricultural circles at the moment is to suggest the introduction of vocational training in the ordinary school curricula. The Committee rightly decides against this proposal, but agrees with compulsory school attendance until fifteen and part-time continuation education until eighteen, in which both cultural and vocational training would be given, and in the latter connexion the Young Farmers' Clubs movement is commended. Up to this stage the Board of Education will be in control.

The main defects of the present system are considered to be due to the absence of any controlling authority responsible for the organization of agricultural education; the number of different authorities providing agricultural education; and the diversity of the sources and means of finance. To remedy this, it is proposed that a central statutory authority, to be called the National Council for Agricultural Education, should be set up. This Council is to be so constituted that it is outside the Ministry of Agriculture, but under the control of the Minister (an extraordinary proposal in view of the average life of a pre-war minister), and to be responsible for providing, at the cost of the national exchequer, for the different branches of agricultural education. At first sight, this cuts across previously recognized systems by removing agricultural education completely from the control of local authorities. One can scarcely imagine that the suggestion will be accepted without question, and indeed one member of the Committee presented a minority report on this very subject. While it will be generally agreed that local authorities have not always functioned satisfactorily, a different attitude would probably have been adopted with more specific guidance and the availability of adequate means, but again it should not be forgotten that the War has given a new complexion to ideas even in relation to reforms in local government.

The Committee considers that farm institutes should be established in practically every county, with the object of providing training for those who are to become small farmers or to occupy posts of responsibility as agricultural workers. The type of training in these institutes is outlined, and the proposals are based on the successful experience of some of the existing centres. Attention is directed to the necessity for avoiding extravagance in the lay-out of farm institutes, and this is particularly necessary judging from some of the pre-war efforts in this direction. Farming and educational opinion generally will support the extension of farm institutes, for their usefulness will also serve some of the needs of vocational education in the counties through short courses in rural subjects for members of the teaching profession, thus necessitating contact with the Board of Education. It is to be hoped, however, that such courses as are given to teachers will be more on broad principles than on specific topics.

So far as the roles of agricultural colleges are concerned, these are regarded as essential for supplying opportunities at a higher standard than that provided by farm institutes, but below the scientific standard required for a university degree. Hitherto, colleges have had to compete with each other and with other centres providing agricultural education, and by reason of financial uncertainties courses of a very varied character have been provided. The South Eastern Agricultural College at Wye is within the University of London, and a similar relationship exists between the Royal Agricultural College, Cirencester, and the University of Bristol. The Midland Agricultural College, Sutton Bonington, which started at University College, Nottingham, is about to rejoin the parent stock. Cold water is poured on a widespread development of this trend, but the opinions of the Committee are not consistent. They suggest that for agriculture "the whole of any course leading to a degree should be taken in the University itself so that the benefit of contact with teachers and students engaged in other subjects should not be lost". Yet for horticulture it insists that "every effort should be made to induce more of the Universities to offer courses leading to degrees as well as graduate courses leading to diplomas in the same subject. They should be given in a separate department, but there must be contact between it and the science departments and the department of agriculture where it exists". It is difficult to understand that what is right for horticultural graduates is wrong for agriculture. One criticism made concerning the farms attached to some of the colleges is that they do not, either in farming or equipment, reach a sufficiently high standard. It is difficult to understand how the Committee found it possible to examine this aspect carefully, and it would have been fairer if the criticism had been qualified. Indeed, more definite criticism of the college farms is essential, if any important development can be expected to accrue.

By contrast it is interesting to note the restrained references to the university departments of agriculture ; but their functions are more specifically defined than in the case of the colleges. Suggestions are made for the avoidance of competition with centres providing lower-grade courses, and a very strong point is made of the need for providing an increasing number of candidates who have had a university training for technical and other posts. No one will disagree with this suggestion. People of independent thinking will be inclined to appreciate the autonomous character of the universities as centres of education, by comparison with the very tight reins by which other forms of agricultural education are to be controlled. The demand for university courses has increased considerably in recent years. Young people who would have been satisfied previously with a diploma course are now advised in their own interests to read for a degree, especially when they wish to enter the technical service. A criticism of many degrees, however, is that candidates can qualify without having had any satisfactory experience of practical agriculture, and it is in this deficiency that practical agriculturists have had most cause for complaint. The suggestion is made that in the case of students who ultimately wish to make the closest contact with farmers, adequate farming experience should be acquired before entry upon the university course. At the present, Leeds is alone in requiring evidence of this pre-university practical training. The suggestion put forward by the British Association Committee on Post-War University Education that all university students should spend at least one year in extra-mural pursuits (see NATURE, Dec. 19, 1942, p. 718) should do much towards meeting this criticism.

A re-casting and re-grouping of the advisory services for the whole range of agriculture is recommended. The Committee has appreciated the difficulties that belong to the present system, where the control is often ill-defined, the facilities at the provincial advisory centres very inadequate and the co-operation with the county services not always as close as it might be. The new proposals tend to result from the organization of technical services operating for the purposes of the war-time food production campaign. Already in most counties the Ministry of Agriculture has taken over the county agricultural staffs, while counties have been subdivided into districts of convenient size with technical officers in each district. This arrangement is regarded as a satisfactory one, though it should be observed that the staffs concerned work under the control of county executive committees that are constituted on a non-democratic basis. Some continuation of this control is envisaged after the War, though probably the method of appointment will harmonize more closely with traditional British ideals. The proposed county organization is to be linked directly with the specialist advisory service, which will operate from a provincial centre or sub-station. At the present time there are thirteen provinces in England and Wales, each university department and major agricultural college acting as a provincial centre. The new proposals suggest larger provinces, numbering six in all, with headquarters located in a university city, though not necessarily part of the university. The proposed centres of the provincial organization are Leeds, Birmingham, Cambridge, Reading, Bristol and Aberystwyth. It is proposed to appoint a chief advisory officer at each provincial centre, his duties being to co-ordinate the work of the specialist staff. Similarly from the provincial centre a chief provincial organizer will direct and co-ordinate the work of the county organizers and their staffs throughout the province, while a provincial administrator will be the administrative head of both branches in the province.

These proposals are logical, but they suffer from several fundamental weaknesses, the chief of which is that no provision is made for the direct contact which now exists with the centres of higher agricultural education, while the new provinces are unwieldy in size and in certain cases eliminate strong county loyalties. If the present teaching centres are to be divorced from their contact with advisory specialists, the student life of the country will be very much the poorer, and it is to be hoped that reconsideration by the implementing authorities will be given to these points. It may be urged that when a better standard of education obtains among the rural community and advantage is taken of the facilities to be created for technical training that less responsibility will be shouldered by the specialized advisory staffs. Many of the problems confronting county organizers to-day result from the lack of fundamental knowledge of the rules of good husbandry and the application of scientific knowledge. Even a highly qualified race of advisers will not restore prosperity to an industry that depends for its well-being to a great extent on the skill and craftsmanship of the agricultural worker. The farmer of the future must be equipped to lead and direct his men. The Committee recognizes that two types of advisers are necessary : one highly qualified and scientifically trained, who will be presented with opportunities that compare favourably with other professions ; the other who will command respect by reason of technical qualifications that are combined with a sound knowledge of agricultural practice.

Even though complete unanimity is unlikely to result from the various proposals put forward, it is necessary that steps should be taken to overhaul the pre-war organization and control. That questions of finance have been at the root of many previous deficiencies is strengthened by the suggestion that the implementation of the Luxmoore proposals will involve an annual expenditure of £2,500,000 and a capital expenditure of £3,500,000, compared with a total expenditure of £606,385 in 1938–39. It is as true of agricultural education as of farming itself, that its efficiency is dependent on the availability of adequate financial resources to provide the men and equipment necessary for the work.

MODERN VIEWS ON EMULSIONS

The Theory of Emulsions and their Technical Treatment

By Dr. William Clayton. Fourth edition. Pp. vii+492. (London: J. and A. Churchill, Ltd., 1943.) 42*s*.

THE problem of bringing the results of fundamental research to bear upon industrial practice represents one of our present-day difficulties, and one which is likely to be accentuated in the future. Dr. Clayton has therefore performed a very useful service in providing us with an account of emulsions which will undoubtedly interest both practical industrial chemists and also those concerned with elucidating the basic principles of these complex systems.

Regarding industrial emulsions, the author has wisely restricted his attention to certain types, and used these to illustrate the broad physico-chemical principles involved; so that, of nearly 500 pages, more than half is devoted to discussions on the wide range of relevant fundamental principles.

Within recent years, considerable understanding of these underlying principles has been acquired from the study of adsorbed and insoluble films at the air/water and oil/water interfaces, and in this edition the first two chapters now introduce these newer investigations. The major points discussed are surface and interfacial tension, the Gibbs theorem in relation to adsorption, foaming and insoluble monolayers, and an outline is given of the techniques available for the study of interfacial films.

Approaching emulsions from a rather different point of view, Chapter 3 deals with dilute emulsions as examples of oil hydrosols, in particular with the electrical double layer and its bearing upon emulsion stability.

Then follows an account of the various types of emulsifying agents, and methods of assessing their efficiency, succeeded by a chapter on emulsion properties such as viscosity, electrical conductivity, and optical. It is a pity that Pickering's oft-repeated statement, that 99 per cent oil-in-water emulsions can be obtained, is still given prominence, although this was disproved by Lawrence some years ago. A similar criticism can be made of the work of Newman, quoted on p. 228.

The numerous theories of emulsions which have been proposed are reviewed at some length in Chapter 4, and this leads naturally to the question of dual emulsions and of inversion of emulsion type. It is in these fields that considerable advances have been made in recent years.

The remaining chapters, with the exception of the last, are concerned essentially with biological and technical aspects of emulsions, and the author's acquaintance with the latter is well shown by his excellent treatment of these topics. The importance of emulsions in biology, particularly in relation to fat metabolism, needs no emphasis.

After the final chapter, outlining such physical measurements as surface and interfacial tension, determination of emulsion type, and size-frequency analysis, there follow two appendixes, the first concerned with the separation of technical emulsions, the second a summary of the important patents since 1934 in which emulsions are involved.

The references throughout the book appear to be extremely complete, and due recognition is given to all the innumerable workers in this most diverse and fascinating field. In the opinion of the reviewer, however, a more critical, even if necessarily more biased, attitude might well have been taken in dealing with the more controversial of the fundamental questions, since due appreciation of the various, and often apparently conflicting, theories can scarcely be expected from the non-specialist.

The paper on which the book is printed is unusually good for these days, and the printing excellent, although a rather large number of smal typographical errors were noted during perusal o the book. It is a pity that this, like the majority o war-time publications, is so expensive, particularl in view of the wide field which it covers and it consequent interest to so many.

A. E. Alexander.

THE BEHAVIOUR OF BIRDS

Bird Display

An Introduction to the Study of Bird Psychology
By Edward A. Armstrong. Pp. xvi+381+22 plates
(Cambridge: At the University Press, 1942.) 21*s*. net

THE somewhat supercilious attitude of th laboratory zoologist to the study of birds, i less prevalent than formerly, is not entirely a thin of the past. The notion that to study a dead bird i a laboratory is a permissible occupation for a seriou zoologist (though to study some more deserving kin of animal such as a protozoon or an echinoderm would be better), but that to study living birds i the field is mere dilettantism unworthy of a real ma of science, dies hard. This kind of attitude is, in fact only a particular example of the gulf between th laboratory and museum zoologist and the fiel worker which is happily being more and mor effectively bridged at the present time. So far as th study of birds is concerned, the ornithologists themselves, or some of them, have afforded a certai excuse for the old sneer, but the work under revie provides a very good illustration of the contributio which modern field ornithology is making to genera biology.

It is in the field of behaviour in the wide sens that the study of birds has probably most to offer t the general biologist, and in recent times the critica study of the behaviour of wild birds has occupied th attention of biologists of first-rate ability, such a Huxley, Lorenz, and a number of others. The scientif investigation of bird behaviour centres very largel around those formalized activities which are embrace under the general term of display, and in this connexion the possibilities of mutually advantageou liaison between field and laboratory studies a happily exemplified in the relation, now well established, between the displays of birds and the physiological processes of reproduction.

In addition to the contributions of trained biologists in the realms of both fact and interpretation a great number of intelligent amateurs have give careful accounts of display activities which they hav observed, and these records are scattered through man journals and other ornithological works in a numb of languages. The result is that a very considerabl though widely dispersed, body of material is no available for analysis and synthesis. On the pure descriptive side the known facts about the displa behaviour of individual species of British birds have been summarized fairly fully for the first time in the recent "Handbook of British Birds"; but a sound general work on the whole subject was very much needed. This Mr. Armstrong has now provided.

The magnitude of the advance since Darwin made the first scientific approach to the subject in his presentation of the theory of sexual selection may be gauged by the mass of observational data existing to-day in contrast to the meagre material available to him. There are many points of detail and some of larger import which remain obscure or imperfectly understood, but at least a coherent general picture (differing a good deal from Darwin's conception) is emerging, thanks to the labours of the pioneers already referred to. Broadly speaking, the striking and frequently spectacular manifestations of avian display are not generally concerned so much with the choice of a particular mate as with the proper synchronization of the reproductive rhythms of mated pairs or with the maintenance of an effective 'emotional bond' between them. As regards the former function, it may be remarked that the importance of visual and other exteroceptive factors in influencing reproductive processes is now widely realized and has been especially stressed by Marshall, but for a proper approach to an understanding of display in birds it must be viewed against a wider psychological as well as physiological background.

Mr. Armstrong has a wide knowledge of comparative psychology, and, as indicated by the sub-title of his book, it is on the psychological and behavioural aspects of display that the main emphasis is laid, though not to the exclusion of others. Though the subject presents a wide field for further productive research, the time was ripe for a survey of progress up to date by a single author, and in the main Mr. Armstrong has carried out his task very adequately. The result is a highly interesting and stimulating book, and the author has been markedly successful in the way in which he has worked into the general picture a wealth of illustrative examples from published sources and original observations. As an ornithologist he has the right combination of field experience and grasp of the literature, and his interest n animal and human psychology enables him to draw some instructive parallels from other groups, and sometimes to point out suggestive similarities in the basic emotional make-up and 'ceremonial' behaviour of man and the lower vertebrates. The concluding chapter on physiological aspects of display hows that he has studied the specialized literature of this subject not only on birds but, so far as relevant, on other vertebrates with considerable care. It may be observed in parenthesis, however, that it is a pity hat the unqualified statement that Rowan's crows with gonads enlarged to the spring condition in winter went north when released, "fulfilling the pring migratory impulse", goes on being copied into books. It is true that there was considerable circumstantial evidence that a majority of the treated birds did go northwards, but in fact the numbers of actual recoveries from north and south respectively were identical, and Rowan himself has not claimed hat the results were conclusive.

Discussions on the related phenomena of song, erritory, nest-building, social behaviour and so on erve to emphasize that display has inter-relations with almost the whole range of bird behaviour. In a ew instances the ornithological specialist will detect minor slips or cases where an isolated observation has been a little incautiously generalized, but these are not serious. Nor is it other than natural if experienced students are inclined to differ from the author on theoretical points here and there. What is much more important is that the intelligent field observer, who may not have time or facilities to study the original sources in detail, and the general biologist who wants to know something of the subject, have at last a single work from which they can obtain a sound and trustworthy account of facts and theories about bird display, and from which, thanks to an extensive bibliography, they can readily proceed to more advanced study if they wish.

B. W. Tucker.

THE BRITISH TRADITION

The British Way

1: A Comment on British Democracy. By Sir Hector Hetherington. Pp. 48. 2: The Temper of British Ideals. By Prof. John Laird. Pp. 51. 3: The British Method of Government. By A. K. White. Pp. 63. 4: British Political Institutions. By Prof. Andrew Browning. Pp. 52. 5: The British Way in World Trade. By Dr. Alec L. Macfie. Pp. 64. (Glasgow: Craig and Silson, Ltd., 1943.) 1*s*. each.

One of the reasons commonly advanced in pressing for a statement of Allied war aims is that such a statement contributes powerfully to the stimulation of the maximum war effort by its effect on morale. It would be unwise to discount that effort unduly, and the Prime Minister's recent broadcast speech is at least in part an admission of its importance. A no less potent source of inspiration for the war effort is, however, to be drawn from the British achievement in the past. We are slowly becoming aware that our habit of self-depreciation is apt to have untoward consequences. To say the least, it does not promote understanding and smooth co-operation with others of the United Nations, particularly with the U.S.S.R. or even with the United States. Persistently to understate our effort and capacity is to play into the hands of our opponents and present them with opportunities for suggesting that our contribution to the common cause is negligible, or that we are allowing our allies to bear more than their share of the burden.

There have been welcome signs of late that this danger has been realized. The right note has been struck in the speeches not only of Mr. Churchill, General Smuts and others but also in the Press—an admirable article, "The British Achievement—No Apologies" in the *Round Table* for December, is an excellent example. Mr. E. F. M. Durbin's "What Have We to Defend?" and Sir John Orr's "Fighting For What?" are other notable instances of a spirited defence of the British tradition, which is as stimulating to ourselves as it is destructive of the attempt to foment misunderstanding. The series of pamphlets, "The British Way", are well calculated to further this work. Without being narrowly nationalistic, those before us give an admirable interpretation of the British heritage, our outlook and way of life and the contribution we can make to the building of the post-war world. They are equally calculated, if these first five can be taken as a fair sample, to stimulate some of the creative thinking required if we are to reshape our institutions to serve our own ends as well as those of the world.

The pamphlets are naturally enough not all of equal merit. Sir Hector Hetherington gives the series a fine start with "A Comment on British Democracy", which goes right to the heart of those questions of the machinery of government and the relations between industry and the State on which many minds are now exercised. The dual function of government is well put: to manage as efficiently as may be the public business of a society; and to manage it also in such a way as to define, protect and enlarge the rights of the ordinary man and woman who are subject to its rule. For these functions to be discharged under a democratic system, which offers to ordinary citizens the opportunity of genuine participation in the business of government, there are three essential conditions: first, an effective arrangement for enforcing the responsibility of the government to public opinion; secondly, the maintenance of genuine opportunities of creating a public opinion; and thirdly, the government should be prevented from acting directly upon any citizen subject to its authority.

Sir Hector points out that these three basic principles have been established by British experience, and that we have produced a reasonably good working model of a democratic society. But whether the instruments we have shaped in government, industry and education are to survive depends on the quality of mind and will of our citizens, and especially of our leaders—whether we recognize widely and wisely the duties that are the counterparts of our rights and liberties and learn to use our freedom to make a community where we may live as a sensitive, creative and happy people should live. Whatever our past achievements, no democratic society can endure except in so far as its citizens learn that no man has a title to benefits unless, according to his power, he pays the cost.

Prof. John Laird's "The Temper of British Ideals" strikes the same note. The fundamental assumption of democracy is that the essentials of living and acting together are and should be a matter in which everyone should be a responsible participant. He places timely emphasis on the way in which we have achieved a very great freedom for speaking our mind about public affairs and for equipping our minds in such a way that, speaking them, we have the chance to speak sense, and he hints at the problem still before us in establishing the freedom and proper use of the air. Over our system of education, of justice, our religious toleration, our Colonial administration, Prof. Laird passes with calm appraisal, and emphasizes that both Great Britain and the United States have shown and are showing that British ideas can be adapted to the ideas of peoples who think upon their own lines and not upon ours.

Mr. A. K. White's discussion of the British method of government, by debate and discussion, is both penetrating and realistic. He does not conceal the difficulties or dangers inherent in this method, but his analysis of the group discussion method is highly pertinent to many of the problems confronting us in reconstruction, in industry and elsewhere. The real issues are laid bare and the fundamental conditions defined firmly and with precision. Discussion, he points out, is a co-operative undertaking as well as a natural political instrument and an educational method. Unlike force, it is a dynamic method, but it is helpless when interests are too opposed and prejudices too stubbornly held. Accordingly the democracies must face the facts of the great society and harness them to their own purposes.

Suggesting that the democracies should now make deliberate use of suggestion to cultivate the necessary and desirable measure of solidarity in the people, he urges, besides greater opportunities for personal contacts between all grades of society, and machinery for a fuller exchange of views and interests between them, that the need for instruction in discussion should be met by establishing, in normal times as well as in war, a central bureau or Ministry of Information to act for the Government as a whole as public relations officers now act for separate Government departments. Mr. White is not blind to the dangers of such a suggestion. The duties of such a Ministry in a democracy are in direct contrast with the functions of a totalitarian Ministry of Propaganda. It would ensure that the public interest overlay discussion and thus secure the essential condition for successful Party government. Enlisting suggestion in support of discussion at the point where the latter method is in most need of assistance, it would help to solve the fundamental problem of enabling the mass of the people to discuss politics intelligently and share intelligently in government.

Mr. White is concerned less with the past than with the present and future—he has wise words on planning and discussion and representative government. The onus, he reminds us, is on the planners to show that there is a satisfactory substitute for the Party system and responsible government in general. If, however, he is provocative, he is also constructive, and scientific workers may well find his essay one of the most stimulating in this admirable series.

The natural counterpart to Mr. White's essay is that of Prof. A. Browning on "British Political Institutions". This concise and lucid analysis of the three elements in our constitution and the problems arising out of them, such as those of the headship of the State, the representative body, and of the relation between the State and the individual, stresses the capacity of the British constitution to adjust itself to meet the changing needs of changing times. An equally important factor in its success is the fidelity with which it reflects the outlook and genius of the British people. Its stability illustrates the national dislike of unnecessary change. Its adaptability reflects the equally strong national consciousness that stagnation is fatal. Its essentially practical character and failure to conform to any logical scheme of political organization reflect the national distaste for theories, and the tendency to judge everything solely by its results.

Dr. A. L. Macfie's pamphlet in some ways is the least happy of the five. Somehow his summary of the growth of the British system of free trade in the hundred years after Waterloo, of the collapse to anarchy and of the position of trade in a democratic world, for all its merits, just fails to demonstrate exactly the British contribution. His touch is surer in delineating the future and the British opportunity and responsibility. The sanity and constructive suggestions, including that for an international investment board, in the concluding sections of his pamphlet, amply earn it a place in a series of pamphlets, which should meet a real need in Great Britain and which might well be utilized elsewhere by the British Council. R. BRIGHTMAN.

SEEING EVER-SMALLER WORLDS*

By SIR LAWRENCE BRAGG, O.B.E., F.R.S.

THE limit to microscopic resolution is set by the wave-length of light. The degree of indistinctness of an object when seen under high magnification can be estimated if we picture the light which is traversing the instrument reversed in its direction. Instead of light waves scattered by the object passing on to build up the image, suppose corresponding light waves to start from the image and proceed towards the object. The pattern which they build up in the object plane will be, on a very reduced scale, what is actually seen when looking through the microscope, and since the local ether storms which they produce must be at least about a wave-length in each dimension, all sharp edges or fine detail in the object must be blurred to this extent. It is as if we were trying to paint a picture with a brush which gives a broad line, the breadth being the wave-length of light. Detail on a finer scale than a brush mark must escape its coarse stroke. Using the shortest ultra-violet waves for which transparent lenses are available, and transparent media of high refractive index in which to immerse the object, the limit of resolution cannot be pushed beyond 1000 A. (10^{-5} cm. or $1/10\,\mu$). As Abbe pointed out in his treatment of the microscope, this is an absolute barrier set by Nature, and if it is to be surpassed it must be by employing some quite new principle.

All bodies cease to be transparent for ultra-violet light more than an octave beyond the end of the visible spectrum. It is not until we reach the X-ray region that waves are again able to traverse matter to an appreciable extent. This opens up the possibility, which has been exploited in X-ray analysis, of getting information about the form of a body by observing the way it scatters X-rays. Convenient X-ray wave-lengths range from 2·0 to 0·5 A., and so lie in a region 4,000 times smaller than that of light waves. Resolution is correspondingly increased, and is in fact sufficient not only to separate atoms in a solid but even to give considerable information about the distribution of scattering matter in an atom. We have, however, to pay a heavy price for this gain in resolving power. We cannot form an image of an object illuminated by X-rays. Even if the technical difficulties of designing some type of reflecting lens capable of focusing X-rays could be overcome, the amount of scattered X-ray energy is inadequate. Consider, for example, a minute object, about 1000 A. each way, illuminated by ordinary light. Under intense illumination the amount of light scattered by such a body is sufficient for photographic recording but is nearing the limit. Yet such a body contains 30 million atoms, and when it is remembered that the most intense X-ray beam has far less energy than we are able to get in a light beam, it will be realized that even if the X-rays scattered by single atoms could be focused, the energy would be far too small to be observable.

It is therefore not possible to bring the X-rays from each point of the object to corresponding points of an image and so make direct use of their resolving power. It is only possible to observe the intensity of X-radiation scattered in any given direction by the object, and to get all the information we can about the object by interpreting such observations. This limitation decides the peculiar nature of X-ray analysis. In the first place, an object of irregular form gives a most complicated distribution of scattered rays. It is only when the object is a regular repetition of a unit of pattern that the scattered rays are diverted to certain directions, and that it is possible to associate in a simple way the strength of the scattered rays with the form of the unit. Hence X-ray analysis finds its most ready application to the examination of crystal structures where such regular patterns exist. Further, since we can only measure the intensities of the scattered beams, vital information about the form of the object is lost. When an object is viewed by the microscope, light is scattered in different directions by its various parts. These light waves pass through the instrument, and interfere in the image plane to build up a light distribution which corresponds, within its limit of resolution, with the object. The form of the image is determined, not only by the amplitudes of the waves scattered in different directions, but also by their relative phases, since the interference depends on these phases. In X-ray analysis, we can measure the amplitudes of the waves scattered in different directions, but their relative phases are not observable. Hence we have not got enough information to reconstruct the object. An infinity of objects, deduced by assigning any arbitrary phases to the scattered waves, would account for any one set of X-ray results.

The interpretation of X-ray diffraction is therefore like that of solving a cross-word puzzle. We cannot proceed directly; we must guess, and test whether we have guessed correctly. We know that the actual object, a crystal structure, consists of a regular array of certain groups of atoms. We know how much each atom scatters X-rays, and experience with other analyses teaches us much about the probable configuration of the atomic groups, what distance apart they are likely to be, and which are likely to be neighbours. Armed with such experience, possible configurations are tested to see whether they explain all the X-ray results, until one is found which satisfies every check. X-ray analysis has proceeded, as experience has accumulated, from simple structures where the alternatives are few to highly complex ones.

There is a simple optical experiment which illustrates the difficulty of X-ray analysis, and makes a striking demonstration. A cross-grating pattern, with about fifty repetitions of the unit to a centimetre each way, is illuminated by parallel monochromatic light and viewed by a microscope. A convenient object is a series of circular transparent holes, made as a print from the type of process plate used in half-tone reproduction. When the microscope is accurately focused, these holes are seen in their true form. Now the light message received by the microscope under these conditions is a series of parallel beams, the cross-grating spectra. The intensities and directions of these beams remain the same whatever the distance of the objective from the cross-grating. These beams therefore continue to build up an image when the objective is moved away from or towards the object, out of the focused position. The only variation when the objective is moved is in the relative phases of the parallel beams, which on passing through the instrument build up the image. The racking of the microscope out of focus affects the path-lengths of the beams to a different extent. We therefore see a different image for every position of the objective. The image may be regarded as built up of a two-dimensional Fourier series of fringes, and these fringes become very obvious when so thrown out of phase that they no longer build up the true image. If the source of illumination is a mercury vapour lamp, the various wave-lengths build up image patterns of considerable beauty, which resemble a brilliant series of tartan patterns. Every image is realistic, and we cannot focus the microscope unless we know what we ought to be seeing—in this case, a series of round holes. In a precisely similar way, the phases are uncertain in X-ray analysis, and we can only 'focus' because we know we ought to be seeing atoms.

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* Friday evening discourse delivered at the Royal Institution on March 12.

In contrasting X-rays and light, we see therefore that X-ray analysis attains very great resolving power, but is difficult to apply except to structures which are regular repetitions of a simple unit. In the case of light, the complexity of the 'geography' of the specimen presents no difficulty because we can form images, but there is a serious limitation to the resolving power. To what extent has the gap been filled?

X-ray analysis has been extended to ever more complex structures. A classic example is the work of J. M. Robertson on organic molecules. If by getting a first rough approximation to a structure we can determine the phases of the scattered X-ray beams, we can then use the measured intensities to determine the amplitudes of these beams, and so get complete information about the form of the object. The problem is considerably simplified by the fact that in most crystals the unit of pattern has a centre of symmetry when projected on certain planes. The phase is then positive or negative. To put this more precisely, the wave scattered by the unit of pattern as a whole must by symmetry be either in the same phase as, or opposite phase to, that scattered by a point at its centre. By amplitude is meant the amplitude of the resultant wave as compared with that scattered by a pattern of single electrons at the centres. By summing a double Fourier series with these phases and amplitudes, a map of the electron density in the crystal is obtained which is a true 'X-ray image' of the structure projected on a chosen plane.

X-ray analysis is being extended, however, to even more complex fields. Crystals of certain proteins give X-ray diffraction pictures which show that they are extremely regular. Bernal first obtained such pictures, and the work has been carried on by Fankuchen, Mrs. Hodgkin, Perutz and others. The X-ray pictures show a wide array of very fine spots; and if only one could deduce the phases, the intensities of the spots could be used, as in Robertson's work on organic molecules, to build up an X-ray image of a protein. The difficulty of guessing these phases is formidable. A molecule of hæmoglobin, studied by Perutz, has a molecular weight of about 70,000. There are encouraging signs, however, that progress is not impossible. Perutz has discovered a method of making the crystal structure shrink without distortion of the hæmoglobin molecules, which in the fully expanded crystal are separated by sheets of the liquid bathing the crystal. Now if we had a complete plot of the scattering power of a centro-symmetrical molecule for different directions of scattering, we could deduce the phases. They are either positive or negative, and as the direction varies the scattering power must go through a zero value in passing from one to the other. Hence the positive and negative regions of scattering are separated by nodes as in a vibration problem, and with the whole picture before us we could take the central region to be positive, and proceeding outwards change the sign every time we pass through a node. Ordinarily this is not possible, because the molecular scattering factor is sampled only at certain points, namely, the spectra determined by the grating constants of the crystal. When the grating constant itself can be varied, however, as in the case of hæmoglobin, the spectra sweep through the molecular scattering distribution and fall to zero in traversing the nodes. In this way Perutz has been able to trace a number of the nodes, and has reduced the problem of deciding between positive and negative for the inner spots to a few alternatives. Only one of these alternatives turns out to give a reasonable answer. Hence Perutz has been able to get an X-ray image of the protein molecule. This image is still very imperfect, corresponding to a resolving power of about 7 A., but the molecule is beginning to take shape and the process can be extended.

Another example of larger scale structures attacked by X-ray analysis is afforded by the studies of more or less regular fluctuations of the perfect crystal array such as occur in certain alloy structures. Preston's work on age-hardening, Bradley's work on the permanent magnet alloys, and the study by Lipson and others of 'sidebands' are cases in point. When an optical grating is ruled by a faulty engine, so that periodic disturbances of its regularity are produced, the result is a series of false lines or 'ghosts' in the neighbourhood of each spectral line. Similarly, when a crystal lattice is distorted in a harmonic way, each X-ray diffraction beam has ghost beams in its neighbourhood. The separation between the main line and the ghost is a measure of the period of fluctuation. Such fluctuations occur in alloys in a metastable state, when full separation into phases has not been attained. Periods of the order of 100 A. have been studied in this way.

The electron microscope, which has been developed in recent years, is of such absorbing interest because it fills in the wide gap between analysis by light and by X-rays. Experiments in the development of the instrument were begun by Knoll and Ruskin in Germany in 1932. An account of its principles will be found in an address given to the Royal Institution in May 1940 by Prof. L. C. Martin (see Nature, August 31, 1940, p. 288). The electron microscope forms images like the ordinary microscope, while its resolving power is about forty times as great. It owes this power to two factors. In the first place, the Abbe limit, or limit to resolving power due to wave-length, is extremely small. The wave-length of 60 kilovolt electrons is $0{\cdot}5 \times 10^{-9}$ cm. as compared with $0{\cdot}5 \times 10^{-4}$ cm. for yellow light. A corresponding increase in resolving power is not attained, because the numerical aperture of the magnetic or electrostatic lenses employed by the electron microscope has to be made extremely small to avoid aberrations. However, even with the small apertures ordinarily used, the Abbe limit of the instrument is about 10^{-7} cm. or 10 A. Certain imperfections limit the resolving power of the best instruments yet constructed to 30–40 A., which approaches the Abbe value. Causes of imperfection are the aberrations and not completely symmetrical fields of the lenses and the fluctuations in voltage at the electron source. A resolving power of 100 A. is attained without serious difficulty. This high resolving power would by itself not be of service, were it not for another fortunate factor. The intensity of illumination by the electron beam is immensely greater than that for the brightest possible light source. Gabor estimates it as being in common practice 10^6 times as great as the intensity of the sun's image. Hence extremely small masses of matter containing a few thousand atoms scatter sufficient energy to produce an impression on a photographic plate.

The principle of the instrument is very simple. A co-axial magnetic or electric field acts as a lens for a beam of electrons of given velocity. By suitable design the focal length of such lenses can be reduced to a few millimetres. A first condenser lens concentrates 50,000-volt electrons on the object. After traversing it, they pass through an objective lens which forms an image magnified 100 or 200 times. This is viewed in a fluorescent screen with a fine hole at its centre, and a chosen portion of the image is brought over the hole. This portion is again magnified to a similar extent by a final lens, and viewed on a screen or photographed.

The objects must be extremely thin, less than 1,000 A. in thickness, and are of course in a vacuum. They may be deposited on a very fine pellicule of collodion which is laid on a plate pierced with fine holes. Focusing is achieved by adjusting the current in the magnetic lens. It is impossible to view the surface of a solid directly, since transmission must be used. It is possible, however, to examine the contours of a surface, such as that of an etched metal, by spreading a fine film of collodion over the surface and stripping it off, when it retains an impression of the hollows and ridges.

The War has retarded the applications of this instrument which would undoubtedly have otherwise been made, and we can confidently expect that it will open up fascinating new fields in future. On one hand, it gives greater definition to objects that can be seen under the microscope, and on the other it attains a resolving power in the 100 A. region, which is of the same order as that of the larger-scale structures studied by X-rays, so that we now have instruments capable of use in the whole range between the visible and atomic dimensions.

PRESENTATION OF SCIENCE TO A GENERAL PUBLIC*

By DR. ARNOLD RAESTAD

Formerly Minister of Foreign Affairs to the Norwegian Government

ALTHOUGH I am not a scientific man myself, it has fallen to my lot to be connected with certain aspects of the problem of the exposition of science. I have been engaged in examining the problem of how to organize better the presentation of the methods and results of science throughout the world or, in other words, the international dissemination of science. After three or four years of preparatory work, in 1938, the League of Nations, through the International Institute of Intellectual Co-operation in Paris, appointed a committee of scientific men, presided over by myself, to report on the matter. Before I say more about the committee and its work, it may be instructive to record, very briefly, the preliminary inquiries which led to its appointment.

The Assembly of the League of Nations had interested itself, in a couple of resolutions, in the use of broadcasting to promote the cause of peace and to familiarize nations with the culture of other nations. In 1936, an international convention for the use of broadcasting in the interest of peace was concluded. Later, the Institute of Intellectual Co-operation asked me to consider what subjects it might most appropriately pick out for an organized effort in this connexion. The Institute referred more particularly to the cause of peace and the work of the League, and to literature and culture generally, as promising objects for an internationally organized effort. I had to report that, in my opinion, neither the peace work of the League of Nations nor the knowledge of the literature of other peoples lent themselves very well to such a co-ordinated international effort.

But there was another field in which the practical broadcaster knew there was something to be done—science. For some reason or other, the attention of the statesmen of the League had not been focused on the need to disseminate more perfectly a knowledge of science—to publicize science. In most countries of Western Europe, despite the vastly increased effectiveness of the common media of information, the information at the disposal of the general public is less adequate, both as regards the progress of science and as regards current topics involving the existence of a scientific problem, than was the case thirty or forty years ago. The Press, filling its public to the saturation point with news and political views, has only a languid interest in the results and methods of science. The documentary film and the radio have not, in actual practice, filled the gap. As for the radio, it has no doubt rendered great services here, for listeners are easily attracted by great scientific names or fascinated by discoveries in biology or astronomy. But generally speaking, according to reports from many countries, the radio has not given what might have been expected, for a number of reasons. Outstanding men of science very rarely combine the qualities which make a good and attractive speaker on the radio; further, no single country has at its disposal first-rate men in all branches of science.

The Institute of Intellectual Co-operation, in view of the preliminary reports thus gathered, appointed in 1938 a committee of scientific men to consider means of improving, by organizational measures, the way in which the results and methods of science are now presented to a general public. The members of the committee were Dr. Julian Huxley, M. Henri Laugier, Dr. Clarence C. Little, my compatriot the late Prof. Sem Saeland, a Swiss, a Dutch and a Belgian man of science. All modern media of current presentation were considered in turn—lectures, Press, films, exhibitions, radio. The problem was approached from the point of view of science as well as from that of society, and from the point of view of the individual scientific worker as well as from that of organized and collective science. The committee was unanimous in stating as its opinion that the situation called for reforms of an organizational character, that these reforms would have to be carried out, if at all, by existing scientific bodies, and that the organization involved would have to be international in its scope and conceptions.

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* Substance of a paper read on March 20 before the Division for the Social and International Relations of Science of the British Association at the Conference on "Science and the Citizen".

As for the content of the reforms, the committee, still unanimous, recommended the creation of an International Centre for scientific information, the efforts of which would have two main objectives: first, a continuous recording of the progress of science; and, secondly, the mobilization, as need and demand arise, of information on any scientific point of current interest. The material produced would, in principle, take the form of data, leaving the elaboration and the linguistic form to the journalist, the speaker, the film producer, the organizer of exhibitions, etc.

For its full achievement, therefore, a more satisfactory presentation of science to a general public will require the co-operation of three agents: the scientific specialist working to perfect his branch of knowledge and using the symbols peculiar to it, mostly mathematical; the intermediary man of science competent to grasp the symbolisms of a number of sciences and to assess the value of theorems and proofs offered by the specialists; and finally, the popularizer. Now and again, a specialist, and somewhat more often, the intermediary scientific worker, may also be a good popularizer; but the committee was unanimous in emphasizing that the great and urgent need of our time in this domain is for the development of a class of intermediary scientific worker having a very definite role in the life of science, a role important for science and for society alike.

A draft organization for the proposed International Centre was worked out. Besides the central secretariat, which might be reduced to modest dimensions to start with, there would be regional representatives of the Centre, and in each country, the academy of science or association for the advancement of science or corresponding body would appoint individual men of science or groups to carry on collaboration and correspondence with the Centre and its regional representatives and take initiatives. Otherwise, the initiatives would, to a great extent, come from the interested popular agencies themselves—Press, radio, film, theatres, etc.—as well as from the national bodies and authorities engaged in the work of spreading throughout the nation the knowledge and spirit embodied in organized science. Neither the central organization nor its regional or local subdivisions should constitute a barrier between the Press, the radio and other popular agencies and their direct access to scientific men. The news, comments and publications of the new organization should, on the contrary, be an additional help to them. The new organization being conceived as part of the house of science itself, there is no danger that it would develop intolerance and try to exercise a sort of birth-control of scientific ideas.

In 1938, the Rockefeller Foundation had instituted an investigation into the same problems in the United States. Conditions there differ to some extent from those in Europe; for example, greater efforts have been made to spread 'science news' in the Press, and to organize the production of documentary films. On the other hand, peculiarities of the broadcasting service react unfavourably on the attitude of the public to the news about science presented there. The first Rockefeller conference on Science and the Citizen in 1938 was followed by a second one in the summer of 1939. At that time, efforts were being made to formulate a practical programme that might be put before the leading scientific bodies of the world. The War interrupted these efforts. But in the light of recent experience, our aims of those days seem to me now to carry a more urgent appeal than ever.

To prepare for a lasting peace is to believe that we can have a new spiritual world. But there is no new spiritual world making for peace and progress unless it be centred in a greater proportion of willingness, and even habit, in high and low, to submit one's own judgment to the control of facts and to respect, in others, the supreme freedom to ascertain and assess facts. This submission to the control of measurement, and this respect for the truth of any assertion, constitute, if I am not mistaken, the spirit of science. When organizing the world, the United Nations have no more fundamental task, and no more urgent one, than to implement properly international co-operation for an adequate presentation to every people of the results and methods of science. In this co-operation, I do not propose to include nations subordinating scientific research to racial or other prejudices. Under the proposals put forward by the League of Nations Committee, international co-operation is automatically limited to such nations as respect the freedom of scientific thought and expression; and I believe it is best so.

I know that in Great Britain the better dissemination of scientific news by the Press and other popular agencies, and the establishment of a central organization to deal with the numerous international questions which inevitably arise, have frequently been discussed. Now that the United Nations are taking stock of their opportunities and their obligations, the opportunity should be grasped to make the realization of these purposes part and parcel of a remodelled and strengthened international co-operation.

SCIENCE IN INDIA*

By D. N. WADIA

Minerals in War

A GEOLOGIST'S work during war-time consists largely in mobilizing all mineral resources in his own limited sphere for munitions purposes. Free international movement of minerals having ceased, every country has to produce the full quota from its domestic mineral resources. Far-reaching questions will arise in the near future, if indeed some have not already arisen, as to how long minerals from accessible depths of the earth will be able to sustain man's wars.

Man's advancement to civilization from the hunter and peasant stage is due to his mastery over metals and minerals, but this advance has caused serious inroads on the world's stock of minerals and especially of metals. During the century and a quarter between the Napoleonic wars and the present War, the consumption of minerals has been more than a hundredfold of that consumed during the entire history of man on earth, and, so far as metals are concerned, man has used up between 1914 and to-day, between the two German wars, more metals than during any previous period of history. Metals such as tin have almost reached depletion stage, silver is being made to stand substitute for tin, while the extractable stocks of platinum, silver and gold left within manageable depth for the future needs of the world will be very meagre. The consumption of fossil fuels, coal and petroleum, has been at a far more serious rate, so serious that the world's known reserves of mineral oil at the present rate of production will be exhausted in a few decades. The total world coal reserves are larger, but they will last only a few decades longer, if the present acceleration of production and consumption of coal and its use for the ever-lengthening catalogue of by-products continues in the future at the same rate.

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* General presidential address to the thirtieth Indian Science Congress meeting at Calcutta during January 2–4.

So far no checks have been devised for this alarming depletion of the world's underground wealth and this robbing of the earth by the living generation at the expense of future generations. Metals and minerals are a rapidly wasting asset of a country, for which there is no renewal or replacement. Agricultural and forest resources of a land can be rejuvenated by suitable measures and manures, but no fertilizer can revive one exhausted mine, for geological processes require hundreds of thousands of years to form a vein of metallic ore or a bed of coal.

There are some 1,500 distinct species of minerals known; of these about two hundred find application in commerce and industry and are considered economic minerals. Among these again there is a rapidly mounting list of metals and minerals which are of vital use in the manufacture of munitions of war and of highly specialized commodities of strategic use. In the defence programme of a nation under present-day conditions of totalitarian warfare, the metallurgical industry and its ancillary mining of minerals yielding the ferrous and alloy metals, fluxes, refractories and accessory minerals are of essential importance. A significant feature of the distribution of these minerals is the concentration of their production and manufacture in a comparatively few countries in the world, happily nearly three fourths of these being centred in, or controlled by, the United Nations as against the Axis group. Of the total annual mineral production of the world in pre-war years, so much as 85 per cent came from North America and Western Europe; of these the United States, Great Britain and Germany, and latterly the U.S.S.R., contributed more than 75 per cent.

This, however, does not mean that Nature has ndowed these countries to this unequal extent with valuable minerals; it is rather an index of the counry's industrial and technical development and the nergy of the people. The three successive five-year plans of the U.S.S.R. are an example of this. Industrial progress of other parts of the world may materially change this condition. For example, China's vast reserves of coal, hitherto untapped for ack of economic employment, may, in the not distant future, be put to use in metallurgy, or in the production of heat energy or other profitable channels. ndia's resources in iron ore are of a magnitude quite ut of proportion to the two million tons of pig iron per year it has only recently begun to produce. Only n a few districts of Bihar and the Eastern States Agency, the high-grade iron-ore reserves are calcuated to be of the order of 4,000 million tons. Large eserves of aluminium ore are still only potential assets. The minerals of South America and Africa are yet in an early stage of development, while Australia's store of mineral wealth is yet unknown over wide tracts of that region. When these untouched eserves enter production stage, the apparent inequalities will diminish and the countries bordering the North Atlantic basin will not occupy the domnating position in strategic minerals they do at present.

But even so, when the whole world's mineral resources are fully known and mobilized, the stock will not last many generations, if it is made to feed the waste of recurring wars on the scale of magnitude and frequency of the last two world wars. If the supply and free movement of a few ferro-alloys and a few strategic key minerals for non-industrial uses is controlled by some central world organization, the demon of totalitarian war can be banished and other wars shorn of the insane waste involved in military as well as non-military devastations. Then the wreckage of tanks and armour plate can be beaten back into ploughshares and its superior steel released for beneficent uses in peace.

It is no exaggeration to say that half the later wars of history have been directly or indirectly motivated through the desire of gaining access to stores of strategic mineral products, ores, fuels, salts, alloy metals and essential industrial minerals. The international mineral situation during pre-war years was in a chaotic state. While the United Nations were in a state of 'vacuous unawareness' about it, the Axis powers grabbed as much of the indispensable munitions minerals as they wanted, and the War has been waged by them on the stores of hoarded minerals and metals.

Only the adoption of a wise and justly planned international mineral policy framed by an international directorate can preserve peace and goodwill among countries unequally endowed by Nature with mineral wealth. No country in the world, however well supplied it be, is self-sufficient in mineral requirements, nor is any so situated that it can regard its mineral resources as purely domestic or national. Embargoes, tariffs, patent rights and transport controls imposed for political reasons do not offer a solution, but by hindering free movement of minerals become powerful contributive factors in precipitating world wars. Unequal geographical distribution of minerals being an unalterable fact, planned international economy should devise means not only to eliminate this cause of inter-country friction but also to increase the interdependence of nations on each other for their vital trades and industrial needs, and so make minerals a rallying point for international co-operation and goodwill.

The preliminary recommendations of the Conference on "Mineral Resources and the Atlantic Charter", convened by the British Association's Division for the Social and International Relations of Science last July, appear to be on the right lines, but they will not go far enough if their implications are meant to safeguard the interests of the British Empire only, or even of the whole United Nations' group. They should embrace all the free countries and should call for sacrifice from all participating nations of part of their national and natural advantages for the ultimate benefit of all and the future security of the peoples of the world. The main resolution of this Conference reads as follows:

"This Conference, having specifically dealt with mineral resources, submits that, as a first step, the Council [of the Association] should initiate forthwith consultations with appropriate scientific and technical organizations, to secure an understanding on the principles involved. The Conference would further urge that a scientific review of mineral resources, using and supplementing all existing data, should be among the first tasks of any international organization for the social applications of science, such as was envisaged at the recent Conference on Science and World Order. To this end, the Conference recommends that the Council should consider how it might help to promote the establishment of an International Resources Organization, as a fact-finding and advisory body for Governments, as a contribution to world stability, and in the spirit of the Atlantic Charter."

The fourth article of the Atlantic Charter postulates access for all States on equal terms to the raw materials of the world. But if the Atlantic Charter does not unreservedly provide for all peace-loving nations of the earth, whatever oceans bound them, its fulfilment in a partial degree will not achieve the goal of post-war mineral allocation, nor succeed in removing a focal infection point in the body politic of the world.

The position of mineral affairs to-day being what it is, it behoves us as non-Utopian science workers to ask: What is India's place in the world's mineral map? The mineral outlook of the Indian region is on the whole satisfactory both for war- and peace-time requirements. India's resources in minerals of strategic importance, minerals for munitions and defence armaments, base metals, alloys, fluxes, refractories and accessory minerals can be regarded as adequate, in several but not all of them. India is deficient in tin, tungsten, lead, zinc, nickel, graphite and liquid fuels. But in the basic metals, iron, manganese, aluminium and chromium, the country is well supplied, in the case of the former three, in large excess. Our neighbour, Burma, has abundant stocks of the munition metals of which India is in defect, while her oil resources must yet be regarded as considerable. Ceylon has reserves of the world's finest graphite, a mineral indispensable in metallurgy, and of a magnitude sufficient to last a long period. Ancillary minerals such as asbestos, cement, fertilizers, clays, mica, sulphur, various salts, ores and other minerals of industrial utility are available in quantities sufficient for the country's needs, while some are in exportable surpluses.

The experience of the last three years war effort in the production in India of a wide range of munitions, without any previous apprenticeship, is satisfactory proof of the country's adequacy in some respects, though still unequipped in a number of essentials, such as specialized steels, machine tools, manufacture of aircraft, high explosives, automobile engines, big ship construction, etc., on a scale commensurate with her internal requirements.

Social Obligations and Relations of Science in India

Last year, while dealing with the progress of the exact sciences in India during the last thirty years, I stated that the retrospect was satisfying and held out promise of further developments. The time, however, has come, and the events of the last few years forcibly remind us of the fact, that science, as pursued in the laboratory and the field, is becoming more and more a specialist's job and is becoming divorced from the life of the people. Science, as applied to the problem of daily living and the social needs of the common man, is the great necessity of the day. The advent of the motor-bus, the radio and railway engine in the villages of India is not the same thing as bringing science to the homes of our villagers. The impact of science on the Indian masses has come in the form of a rather rude intrusion of machines and mechanics into the essentially simple rural economy of the country, and it is not surprising that this meeting has not been a particularly happy one. It has disturbed the economic structure and created, if not some aversion, an indifference to the cult of science in the popular mind.

But we all know that science is not all mechanics, nor are its practical uses to man the greatest thing about science. The greatest thing about science is the scientific method—the most effective thing man has for discovering truth and the ways of Nature. It can bring solid benefits by releasing life from stagnation and the bonds of ignorance wherever these prevail, whether in cities or in the countryside, among the labouring masses or among the governing class. The awakening to the social obligations of science is of recent date, and even in Europe and America, this aspect of the cultivation of science was for long not realized and left to sporadic individual efforts. With this awakening, a two-fold problem faces science all over the world to-day—to press the newest discoveries and inventions of applied science into the service of agriculture, manufactures, hospitals, homes and schools, and with it so to control the impact of these on man's private life that his mechanized work-a-day life may not be totally divested of all higher spiritual values.

Our future national life and its material well-being largely depend on a wholesome balance being maintained between these two—the impulse to harness science to increase physical comforts of life and a restraining desire to preserve the old-world spiritua calm and simplicity of living. Happily for India this balancing is somewhat of a natural hereditar trait and does not need much emphasis. While i the European countries the evolving of a true synthesis, a *via media*, demands much searching an learned arguing, our age-old traditions have mad this work easier. India's late start in the applicatio of science to industry also gives it an opportunit of planning along right lines. The significance of thi problem has been realized both by our political leader and by scientific men, and some progress is bein made in this direction. I refer to the inauguratio in 1939 of the National Planning Committee unde the chairmanship of Pandit Jawaharlal Nehru, wit the specific object of co-ordinating science with industry in all its phases, and to the establishment b the Indian Science Congress at its Lahore session i January 1939 of a Sub-committee on Science an Social Relations, mainly with the object of studyin the influence of science on India and collecting dat relating to the effects of science on society in India

The National Planning Committee, through it twenty-nine sub-committees, has set out to formulate a programme covering many phases of th future life and activities of India, material, productive, educational, artistic. Their work, unfortunately is in a great measure suspended to-day, though som of the sub-committees have furnished more or les complete, well-documented reports, while others hav submitted interim fact-finding reports. Their conclusions, doubtless, will be subjected to thoroug revision and deliberation by the main body, whic comprises some two hundred of the leading industrialists, publicists and scientific men of the countr before they are offered to the public, but a grea deal of spade work has been accomplished, a valuab mass of ascertained classified details collected an many blue-prints prepared. A planned reconstructio in a greater or less measure of India's commerc industry, finance, land, labour, mining, transpor power-generation, technology alongside educationa cultural and social re-organization is expected t emerge from the labours of this body.

Proposed Academy of Social Science for India

The executive committee of the Indian Science Congress has before it a proposal for the institution of a National Academy of Social Sciences, drawn up by the Sub-committee on Science and Social Relations. It is interesting to trace the origin of this sub-committee, which goes back to the Blackpool meeting of the British Association for the Advancement of Science in 1936, where there was much discussion of the social relations of science. In the following year, a few leading science associations took cognizance of this subject. The International Council of Scientific Unions, with its headquarters at Delft, Holland, at its meeting held in April 1937 in London, established a committee on Science and Social Relations, with Prof. F. J. M. Stratton, of Cambridge, as president. This action of European men of science was followed by a resolution passed by the American Association for the Advancement of Science at its meeting in 1937 urging the various scientific organizations of the world to re-undertake examination of the profound changes brought about by science in human society, and thus be in a position to promote "peace among nations and intellectual freedom in order that science may continue to advance and spread more abundantly its benefits to all mankind". In 1938 the British Association at its meeting held at Cambridge brought into being a special Division for the Social and International Relations of Science, with Sir Richard Gregory as its chairman. This division organized a conference on "Science and the New World Order" in London during September 1941. In conjunction with these sister organizations of Europe and America, the Indian Science Congress instituted a Sub-committee on Science and Social Relations at its annual session held in Lahore in January 1939. This Sub-committee has been working for the last three years and its labours have fructified in the above proposal, which in due course will come before the Indian men of science.

The proposed Academy should be a body of high academic standing and professional knowledge, which can take up long-range problems of social well-being of the people of India with which the older societies and associations established along familiar but too general lines in some cases and rather over-specialized lines in others cannot deal without suspicion of religious or political bias. Socio-medical and political subjects, human relations, anthropology, political science, vital statistics, social biology, population problems, sociological research in particular bearing on various Indian communities, are the subjects on which such an Academy can work in collaboration with the Indian Science Congress and half a dozen other institutions already existing in India for some of the above-named specific objects. It can be a living organ in the body politic of India for voicing the collective opinion and focusing the specialized points of view of numerous isolated working bodies on the one problem—how to promote the well-being of the common man.

The Sub-committee has begun a survey of the status of sociological studies in all the Indian universities. Vice-chancellors of many Indian universities have endorsed the proposal about the Academy favourably, and the secretaries of those learned societies that have been approached have announced their readiness to co-operate. Dr. K. Motwani, secretary of the Sub-committee, placed the scheme before Pandit Nehru last July and, in accordance with Pandit Nehru's wishes, the executive committee proposes to appoint a committee of experts to suggest ways and means of bringing this Academy of Social Sciences into being. The matter rests here.

It is too early to outline the exact tasks to which the Academy will address itself. Its chief function will be to explore those avenues through which the contributions of science may be adapted to the life of the individual and the nation without allowing anti-social applications of science, such as have made a shambles of so many countries, ever raising their heads in our midst. Secondly, the Academy should emphasize an integrated, synthetic approach to every problem, pressing into service the contributions of various basic social sciences such as human geography, anthropology, psychology, economics, political science, philosophy and sociology. The bringing into being of a National Academy so constituted may well become a crowning achievement of the Indian Science Congress.

IMMUNITY TO VIRUSES

In opening a discussion on immunity to viruses in the Section of Comparative Medicine of the Royal Society of Medicine on April 21, Sir John Ledingham said that notwithstanding the immense amount of attention paid in the last twenty years to immunization against virus diseases, Jenner's discovery still remains the touchstone by comparison with which all subsequent efforts in this field must be judged. All attempts at immunization against viruses present the same problem—the preservation in the vaccinating agent of the maximum antigenicity compatible with safety from both immediate and remote sequelæ. The solution of this problem has proved no easy matter and there is still a large field to explore in the exploitation of natural variants of pathogenic viruses of man and animals.

Three fairly general methods were available: (1) the use of the cognate living virus (as in cow pox); (2) the use of completely or partially inactivated living virus; (3) the exploitation of the 'interference phenomenon'. Unfortunately, each virus has to be investigated as a problem in itself, and success with one by a particular method is no guarantee of similar success with others. Cultivation in an unusual host (for example, cow pox in the chick embryo or in tissue culture, rabies in rabbits, yellow fever in tissue culture) may give good antigenic variants; but in the case of vaccinia, there is considerable evidence of loss of antigenicity after prolonged cultivation in eggs. Poliomyelitis virus transferred to the cotton rat, thence to the mouse, and so to the hamster, is so far modified that rhesus monkeys may survive infection with it; such survivors are immune to virulent monkey virus. The value of rabies vaccines is very difficult to assess owing to our ignorance of the probable mortality in untreated cases; according to Webster, the average mortality from rabies among persons bitten by proved rabid dogs, no matter with what vaccine they are treated, is about 0·2 per cent; in man, who is probably relatively insusceptible to rabies, all vaccines appear equally good or equally bad. Webster has therefore devised an improved method of testing rabies vaccines, and has elaborated what he considers an improved vaccine inactivated by ultra-violet light.

The success or failure of partially or completely inactivated viruses seems to depend on the amount of material injected representing a sufficient number of infecting doses of the original virus. Formalized virus vaccines have been found useful for protection against such infections as equine encephalomyelitis and canine distemper; in vaccinia they appear to be useless. In foot and mouth disease and influenza, immunization is complicated by the existence of numerous serological types; and so far in influenza no variant has been found with the necessary combination of negligible virulence and good immunizing power.

Very little use has so far been made of the 'interference phenomenon', wherein inoculation with two viruses is followed by the development of lesions due to one of them, but by the acquisition of immunity to both. A good example is the immunity produced in fowls against fowl pox by the simultaneous inoculation of large amounts of pigeon pox and traces of fowl pox virus. Peltier in Senegal has recently inoculated a large number of natives with a mixed 'vaccine' consisting of vaccine lymph and active neurotropic yellow fever virus. Only the lesions of vaccinia appeared, and the natives were apparently immune to both yellow fever and smallpox.

Even though some virus infections (for example, fowl pox, psittacosis) give rise to little antibody response in the host, it seems clear that a humoral mechanism is the main factor in immunity, for chorioallantoic grafts of skin from fowls immune to fowl pox are as susceptible to fowl pox as grafts from non-immune fowls. When regrafted on to immune fowls and thereby bathed in the fluids of the insusceptible host, they can no longer be infected with fowl pox virus. It is not yet certain whether a high titre of circulating antibody following vaccination betokens immunity to influenza virus.

The study of virus reservoirs might give many hints in the quest for effective immunizing agents. Healthy vampire bats can carry rabies virus, many species of birds carry psittacosis and psittacosis-like viruses, fowls, horses and other mammals can carry equine encephalomyelitis and St. Louis encephalitis, while the virus of lymphocytic choriomeningitis has been isolated from wild house-mice. Under normal conditions the virus remains latent; variations in the weather, the presence of biting insects and appropriate hosts might lead to conditions in which man becomes infected.

Very important advances have been and are being made in attempts to substitute inactivated for active virus; with further developments in recovering viruses from tissues and in methods of inactivation, we may hope to ensure the preservation of antigenicity necessary for effective immunization.

Mr. J. T. Edwards pointed out that measures for the control of rinderpest necessarily differ in different countries. In India, where the native cattle are relatively immune to the disease, greater risks can be taken than in England where all the cattle are susceptible. Four methods of conferring immunity are available: (1) Injection of hyper-immune or convalescent serum (cattle or buffalo). The immunity so produced is immediate, but lasts only nine days, and is liable to produce an unjustified feeling of security, as the infection will remain latent in the herd until the effect of the serum wears off, when infection will flare up again. (2) The serum and virus method gives lifelong immunity, but is expensive and risky; unless both serum and virus are effective, it is of little value. (3) Little progress was made with inactivated virus until it was discovered that most of the virus is in lymphocytes, and that vaccination with extracts of tonsils, lymph glands and lungs of infected animals, killed at the height of the fever and inactivated with 0·7–1 per cent of formalin, gives good immunity. The procedure is safe but expensive, and the duration of immunity very variable. Calves lose their immunity early, older animals may remain immune for two years. (4) Passage of rinderpest virus in goats reduces the virulence for cattle in about eighty passages, and vaccination with this modified virus gives excellent immunity, appearing 2–3 days after inoculation. The method is effective, safe and cheap.

Dealing with swine fever, Mr. T. M. Doyle said that in immunization against this disease, virus followed immediately by serum is effective but expensive, and great difficulty has been experienced in obtaining constant products. Crystal violet vaccine, though not so efficacious, is much more uniform and comparatively easily reproducible. Infective blood is incubated for 14 days at 37° C. with disodium phosphate and 1 : 1000 crystal violet; 1 : 2000 crystal violet, though it has the advantage of not producing any precipitate in the vaccine, is not sufficiently bacteriostatic. Under laboratory conditions immunity lasts for more than twelve months. In field trials excellent results have been obtained so long as pigs were vaccinated *after* weaning; pigs vaccinated before weaning developed only slight immunity.

Dr. C. H. Andrewes remarked that bacteriophages might show the 'interference phenomenon'; coliphages, for example, might inhibit one another, even though one is inactivated with ultra-violet light. Might not interference account for immunity in vaccination against small-pox and rabies? Dr. D. Maclean directed attention to the difficulty of producing immunity to vaccinia unless a vesicle develops —even though deep lesions and local adenitis occur. Dr. C. L. Oakley mentioned the corresponding observation in influenza; if mice are immunized with formolized virus intraperitoneally, they are immune only to the homologous strain, and possess significant antibody to that strain only. When, however, they have intranasal inoculation with living virus, they are immune to all strains if the immunizing dose has produced a lesion in the lung; their antibody is still only to the homologous strain. If the immunizing dose has not produced a lesion, the mice have neither immunity nor antibody.

OBITUARIES

Sir Edwin John Butler, C.M.G., C.I.E., F.R.S.

Edwin John Butler was born on August 13, 1874, in County Clare, Ireland, and was educated at Queen's College (now the University College), Cork. He was senior scholar in 1896. In 1898 he took the M.B. (Hons.) at the Royal University, Ireland, but never practised. During 1899 and 1900 he held a travelling scholarship and worked at Paris, Freiburg Antibes, and Kew. In 1901 he arrived at Calcutta as the first cryptogamic botanist to the Government of India; in 1902 was transferred to Dehra Dun and in 1905 as Imperial mycologist to Pusa, the site of the new Agricultural Research Institute. In 1919 he became the joint director, and in 1920 agricultura adviser to the Government of India. The same year he returned to England as director of the Imperial Bureau of Mycology; and in 1921, his services to India were recognized with the C.I.E.

While still in Europe, Butler had commenced his study of the genus Pythium, and became an adept at isolating its species from the soil; his monograph on the genus was published in India in 1907, and is still in great demand. His special interest in the Phycomycetes, for example, Phytophthora, Sclerospora, and Rhizophagus remained to the end. At Calcutta he was introduced to the fungi of the agricultural crops; at Dehra Dun to the forest fungi, especially as they attack tree roots, and at Pusa finally became committed to crop fungi, which were then poorly known. A ubiquitous weed *Launæa asplenifolia* was a reputed alternate host for Indian brown rust of wheat; its rust, however, proved to be autœcious, and *Puccinia butleri* Sydow commemorates one of his first tasks. Monographs on sugar-cane diseases, wheat rusts (with Hayman), Fusarium wilts, Sclerospora disease, and rice diseases, including one caused by an eelworm, were among his special publications. Five papers on the micro-fungi of India, jointly with H. and P. Sydow, covered the Indian rusts, smuts, Phycomycetes, Ascomycetes, and Cœlomycetes, many new records being based upon his own collections. In 1918, with the publication of his "Fungi and Disease in Plants", he established an international reputation as a plant pathologist. To round off his work on Indian mycology, in 1932 he published, jointly with G. R. Bisby, "The Fungi of India", a compilation of the species recorded up to 1930, and of their literature.

The year 1921 was mainly spent in organizing the new Bureau; but during a two months visit to America, Butler established cordial relationships with numerous mycologists and plant pathologists, and secured their goodwill for his new venture. In January 1922, he brought out the first monthly part of the *Review of Applied Mycology*, and for many years, editing that journal had the first call upon his time. In 1923 he visited New Zealand on his way to attend the Pan-Pacific Science Congress in Australia, and again secured the goodwill of all he met; the recognition of *Phytophthora hibernalis* Carne as a distinct pathogen of citrus dates from that visit. In 1924 he successfully organized the first Imperial Mycological Conference. In 1926 he was elected F.R.S., and was chairman of the Mycological Section of the International Congress of Plant Sciences at Ithaca, U.S.A. In 1927 he was president of the British Mycological Society, and was invited to Nyasaland to inspect the tea plantations there; *Sclerospora butleri* Weston, the type of which he collected, felicitously commemorates this visit. In 1928–29 he was president of the Association of Economic Biologists, and in 1929, the year of the second Imperial Mycological Conference, was also vice-president of the Linnean Society of London. In 1930, he was recorder of the Section for Mycology and Plant Pathology at the International Botanical Conference at Cambridge. In 1931 he was invited to the Sudan, where 200,000 acres of cotton were threatened by black-arm; in 1932 he was awarded C.M.G.; in 1934 was elected to the Council of the Royal Society; and delivered the Lowell Lectures at Harvard University, the home of the famous Farlow Herbarium and Cryptogamic Laboratories.

During this period, Butler's published work was mainly for the occasion, and displayed his many interests. In 1926 at Ithaca, for example, his subject was the delimitation of fungus species; in 1927 the development of economic mycology in the Empire; in 1929 the morbid anatomy of plants; in 1932, to the British Association, tropical plant diseases with "every gradation of severity from the sorghum smut which levies a moderate toll of about ten per cent of the crop . . . to the Panama disease which completely exterminates the susceptible bananas and precludes replanting within any reasonable time". But through it all, his spontaneous interest in fungi as fungi, together with his genial hospitality, attracted to the Institute all sorts and conditions of mycologists. Thus in 1934 A. H. R. Buller dedicated the sixth volume of his "Researches on Fungi" to "E. J. Butler, the distinguished director of the Imperial Mycological Institute, in recognition of his contributions to our knowledge of fungi, and of his helpfulness to fellow workers".

His years of service were marked by his preeminent ability both to appreciate a situation and to state a case. Hence his advice was in constant demand in committee work both by such Government bodies as the Colonial Advisory Council of Agriculture, and such public ones as the Empire Cotton Growing Corporation. Finally, in 1935, he yielded to insistent pressure, and left the Imperial Mycological Institute, where he will long be remembered as a great chief, and became secretary to the Agricultural Research Council. In 1938 he was made LL.D. *honoris causa* of the University of Aberdeen. He was knighted in 1939 and retired for health reasons in 1941. Just before his death, he was back among the fungi again, exuberantly rewriting for a new book the first chapter of his "Fungi and Disease in Plants" in the light of the experience of another quarter of a century.

He died suddenly on April 4, following an attack of influenza: and is survived by Lady Butler, and by a son and two daughters. E. W. Mason.

Commander F. A. Worsley, D.S.O., O.B.E., R.N.R.

Commander Worsley was born at Akaroa, New Zealand, in 1872, and died at Claygate, Surrey, in February last. At fifteen years of age he was apprenticed in sailing ships of the New Zealand Shipping Company and made his first voyage in the square-rigged *Wairoa*. After his apprenticeship days, he became mate and later master of New Zealand Government schooners, among them the *Tutanaki* and the *Countess of Ranfurly*, working in the South Pacific. Afterwards he turned his attention to steam, joined the Royal Naval Reserve and had the usual training with the Grand Fleet. This was in 1908. In January 1909 he joined the Allan Line and made acquaintance during the succeeding five years with ice conditions on the Canadian route.

Worsley was appointed master of the *Endurance* in June 1914, and his abilities and untiring energy soon made themselves known. He was a splendid shipmaster and made an ideal combination with Shackleton. The *Endurance* was crushed in the ice after her adventurous voyage through the ice of the Weddell Sea and the crew then lived for six months on drifting pack-ice, until it broke up in the open sea east of Graham Land. Boats were launched and Worsley was in charge of the cutter *Dudley Docker* in the escape from the ice to Elephant Island. His outstanding feat was the navigation of the *James*

Caird on the historic journey from Elephant Island to South Georgia. It is no exaggeration to say that Worsley's study of the winds and currents of the South Atlantic and his knack of snapping the sun, no matter how adverse the conditions, ensured the success of the voyage and ultimately the rescue of the marooned party on Elephant Island. Worsley has himself written an account of this journey under the title of "Shackleton's Boat Journey", and other incidents of the expedition are to be found in his longer book "Endurance".

On his return to Great Britain, Worsley commanded P- and Q-ships and won the D.S.O. and bar for successful operations against U-boats during the War of 1914–18. He also served on the north Russian front, advising on arctic equipment and transport. On the conclusion of hostilities he again rallied to Shackleton and became sailing master and hydrographer of the *Quest* in 1921. From then onwards until 1939, Worsley sailed on occasional trading vessels. During the present War his activities were many and varied, such as Red Cross work in Norway, ferrying steamers, clearing wrecks, lecturing to troops, and ultimately as instructor in seamanship at Greenwich.

Two events stand out in the inter-war period. In 1925 he was joint leader of an arctic expedition in the auxiliary sailing ship *Island*, which penetrated to Franz Josef Land and of which a full account is given in his "Under Sail in the Frozen North". In 1935 his love of adventure took him to Cocos Island in search of hidden treasure.

Worsley was a man of action, always on the move and extremely alert, both mentally and physically.
He retained this amazing vigour up to the very
and steadily refused to go into retirement. It
hard to believe that he had reached his three sc
years and ten. He was not a man of science in
strict sense of the word, but he was a born natura
and observer, as the logs which he kept on his cru
bear out. Animal life appealed to him and he
a good working knowledge of sea birds, seals
whales. It was as a navigator, however, that
stood supreme, and there is nothing finer than
piloting of the *James Caird* to South Georgia,
island not much more than a speck on the w
South Atlantic Ocean.

R. S. CLARE

NAZI air-raids and artillery bombardments
Leningrad, Moscow and other Russian cities are tak
a heavy toll of the scientific workers who h
remained at their posts. News has just reac
Great Britain of the deaths in this way of the foll
ing entomologists: A. M. Iljinsky (specialist in ins
toxicology); A. M. Gerasimov (lepidopterist); S.
Predtechensky (specialist in Orthoptera and
ticularly in the locust problem); A. N. Reicha
(coleopterist, specialist in Histeridæ); V. E. R
korzev (insect anatomist and histologist); A.
Stackelberg (dipterist); S. P. Tarbinsky (orth
terist); "and many others" as is stated in the le
containing this sad list. All these entomologists w
well-known specialists in their respective sphe
most of them in the prime of life, and these gaps
the ranks of leaders of Soviet entomology will
be easy to fill, particularly when even heavier los
can be expected among the younger entomolog
serving in the Armed Forces.

NEWS and VIEWS

International Relations

IN the first Montague Burton Lecture on "International Relations" delivered at Leeds on October 9, 1942, which has now been published by the University, Mr. J. G. Winant, attempting first to answer the question, why should barbarism be so rife in our modern world, suggested that one of the reasons was that in the years following the War of 1914–18 we neither tried to build a kindly world nor apportioned a sufficient percentage of national income to be armed effectively against aggression. Further, we did not give sufficient attention to either national or international machinery to allow the people effectively to meet social and economic needs within their own countries, or to give effective expression to the vast majority of people who wanted peace. Our consciences had also been blunted in the face of challenges to the rules of civilized life, and this slow decay of conscience occurred in a world of declining economic stability.

Our first task, said Mr. Winant, is to rebuild the moral basis of our life, neglect of which invites a revolution against the very conception of moral law. A world revolt against civilization will begin again, even after the defeat of the Axis, unless we destroy the roots of cynicism by proving in conduct our belief in justice, freedom and Christian brotherhood. We do not need a new tradition or a revolution, but only to preserve and make real in a world of action the great traditions we have inherited and which
should be realized in free government and
Christian faith. We do not need a new econo
system, but to learn to use the system we alre
possess so as best to serve our purposes. The
question is whether they serve best the ends of
society, in promoting the justice and equality
opportunity and freedom which are its purpose.
need above all to subject the machinery of life to
purpose, in place of being slaves of that machin
Under the pressure of the terrible events of to-d
we must be great of purpose or we cannot surv
The moral and high political aims of our soc
must be put first, and economy machinery m
their servant. We are fighting for a second cha
to make the greatest of traditions come true. T
is nothing to substitute for it; we must go ah
perfecting the political and moral system we h
inherited or we let the system perish and the w
revert to barbarism. He believes that we could b
beyond nationalism an orderly international wo
but nothing less than to serve our great tradi
greatly would serve us in the disasters of to-da

World Waste and the Atlantic Charter

IN a lecture on "World Waste and the Atla
Charter" at the Union Society's Hall, Oxford (Oxfo
B. H. Blackwall, Ltd.; 1*s*. net), Sir James M
chant points out that the lessening rate of discov
and the intensive use of minerals have already, in
pendently of the increased demands due to the W

led to shortages here and there which are not being compensated by discovery. Salvage and recovery are with us as permanent aspects of the conservation of resources, and not only as part of a war economy. Scrap recovery is of increasing importance and must figure with natural resources in any scheme affecting the control of raw materials. Referring to remarks made by Mr. Hutchings, principal director of salvage and recovery, Ministry of Supply, regarding economy in use and in manufacture, Sir James emphasizes that there must be substitution of one material for another so as to prevent a scarcity of one raw material holding up production. Salvage involves policy and planning to ensure that the materials required are in the right place at the right time and in the right amount, and the discovery of available materials, as well as their collection and disposal to the best advantage. In regard to metal scrap, an international convention for marking material made from the main types of alloys to help in their easy identification is required, as well as improved methods for sorting and cleaning old scrap and getting it into suitable form for re-melting. Losses by corrosion when scrap, often finely divided, is kept for long periods, must also be avoided by early removal of dumps. In the grand strategy of post-war reconstruction, the prevention of all waste throughout the world, Sir James urges, must occupy a dynamic position, and he includes in his survey not merely minerals, rubber, bones, oil, paper, kitchen waste, but also wastage of human material in industry or through defective education.

Engineers' Study Group on Economics

THE tenth anniversary of the foundation of the Engineers' Study Group on Economics was marked on May 8 by a social gathering at the home of Lady Rhys Williams; among those present were Sir Richard Gregory, Prof. F. Soddy, Lord Marley and representatives of organizations interested in economic and social reform. Formed initially by a group of engineers through the efforts of the late Mr. John L. Hodgson, the Engineers' Study Group soon enlisted the support of other technical and scientific workers and, under the presidency of Sir Richard Gregory and later of Sir Richard Paget, set out to prove that the scientific method can be applied to social and economic problems. Among its earlier reports were an "Analysis of Twenty-four Social and Economic Systems" and "The Design of a Family Budget with Special Reference to Food" (see NATURE, April 11, 1936, p. 627). Much of the work of the Group—which covers an unusually wide field, from statistical data on national production to psychological hints on how to deal with misguided enthusiasts—is issued in the form of duplicated reports which are circulated among members and associated organizations.

Perhaps a unique feature of the Engineers' Study Group on Economics is the way in which it sifts all types of suggestions and helps those who wish to build up groups and associations in the pursuit of desirable social ends. Lady Rhys Williams, who has prepared some carefully thought out proposals on the lines of the Beveridge Report (see NATURE, December 12, 1942, p. 692), referred to her long association with the Group. Mr. Raymond Perry, chief executive officer of the Committee for the Scientific and Industrial Provision of Housing—whose report on pre-fabrication may well prove an important step in solving the post-war housing shortage—acknowledged his indebtedness to the E.S.G. and to the Research Co-ordination Committee, at the headquarters of which his own committee began its work. Prof. Jacques Metadier, wishing to start a journal to foster co-operation among scientific men of the United Nations, approached the E.S.G. and received help and advice which led to the publication of the "Solidarity" series. Mr. W. H. Edridge, of the Joint Council for Monetary and Economic Research—a body which has brought together many separate groups working towards monetary reform—likewise mentioned the collaboration of the E.S.G., which through its unobtrusive and disinterested help has won the confidence of many attempting to solve the problems of a rapidly changing world. Representatives of other organizations added their commendation of the work of the Engineers' Study Group, the address of which is now 20 Buckingham Street, London, W.C.2.

Crack Detection in Non-Ferrous Materials

AT a demonstration given in London recently, the potentialities of the 'Hyglo' system of detecting flaws in non-ferrous metals and other materials were demonstrated. From its name it will be recognized as an application of the well-known phenomenon of fluorescence to the illumination of flaws, cracks, inclusions and porosity, which are thereby rendered quickly noticeable when examined under the ultra-violet lamp. This particular system is specially notable, from the point of view of the user or potential user, by reason of the simplicity, rapidity and certainty of its operation, and of the ease with which it can be introduced into a scheme of mass production. The articles to be examined are first dipped for about two minutes in a solution containing the fluorescent material and a substance which at its boiling point produces a vapour to quench fluorescence on the surface. By preparing a sufficient number of articles at the end of each day, the work of inspection can be started at once in the morning and can proceed without interruption. When the articles so treated are brought under an ultra-violet lamp, the fluorescent material which has penetrated the cracks, spongy places or other flaws glows strongly and defective articles can be recognized at once.

At the demonstration, various specimens could be examined, and these included aluminium castings, bronze rings and porcelain insulators. In most of these the defects might easily have been overlooked in visual examination even with the aid of a magnifying glass, but under the ultra-violet lamp they were unmistakable. It was evident that to some extent the seriousness of a particular flaw might be gauged by the greater intensity of the fluorescence due to the deeper penetration, but this should be regarded as of secondary importance, as the first consideration is that the flawless articles should be separated from those which have defects—the final decision on any defect is a matter which requires individual inspection. The suggestion that the system could be operated in conjunction with a conveyor belt is quite feasible, as two lamps can be used. After passing the first lamp each article is turned over by an automatic arm and so both sides come under examination. It will be noted that the 'Hyglo' system requires the two essential operations of dipping and exposure to ultra-violet light. The ancillary operations of washing and chalk dusting have been entirely eliminated and as a result the work can be carried out by unskilled personnel after perhaps half an hour's training in the routine. Further, as the liquid used is self-regenerating and waste is reduced to the absolute minimum, the cost of the process is moderate; an example given was the case of a production run of 1,600 articles each having a superficial area of 2·1 sq. ft., in which the operating cost, including energy, drag-out losses and labour at standard rates, was 0·08*d*. per sq. ft. The makers of the plant are High Grade Metal Tests, Ltd., 24 Marshalsea Road, London, S.E.1.

Subnormal Factors in Human Personality

In his presidential address before the Section of Psychology and Educational Science at the thirtieth Indian Science Congress at Calcutta in January 1943, Dr. B. L. Atreya spoke on the "Supernormal Factors in Human Personality". In a rapid review of his chosen field, Dr. Atreya sketched in broad outline the history of the subject as it was known in the West and pointed out the work that had been done since the early days of the Society for Psychical Research, when investigation was hindered by lack of means and by the slight development of those statistical methods whereby results might be quantitatively analysed.

Although Dr. Atreya appears not to have seen fit carefully to distinguish the wheat grains from the mountain of tares, his outline of the mass of material will perhaps fulfil the purpose of dissuading future students from tackling the subject unless they are prepared, not only to face some of the most formidable of psycho-philosophical questions, but also to make themselves acquainted with almost the whole range of studies dealing with the psychology of deception, testimony and so on. Competent investigators are rare and urgently wanted, and it is to be hoped that Dr. Atreya's address will stimulate Oriental students to apply Western methods to the abundant material available in their own lands.

Prawn Fisheries of India

Dr. B. Chopra, in his presidential address to the thirtieth Indian Science Congress, Calcutta, 1943, has gathered together interesting information concerning the various Indian prawns of economic importance and their fisheries. There are many species of edible prawns in India, the most important and largest being the so-called sea-prawns or Penæids. These apparently breed in the sea, the young migrating to the lower salinities of backwaters, lagoons and estuaries to return again at maturity to the sea to hatch their eggs. Among the freshwater prawns the members of the Palæmonidæ occur in enormous numbers with extensive migrations from fresh to brackish waters, presumably for breeding. The tiny Sergestid Acetes, rarely more than an inch in length, makes up for its small size by its abundance and occurs in estuaries and backwaters, but rarely penetrates beyond tidal influence. Not a single complete life-history of any of these prawns is known, and there is here a great opportunity for research which should yield good results. Methods of fishing and curing are mostly very primitive although in certain parts, notably Madras, much progress has been made in improving methods, gear and boats. More research is necessary in every direction, and Dr. Chopra's address indicates the special needs of the industry.

Folk-Lore of Epilepsy

In a recent paper on this subject (*Med. Press and Circ.*, 1, 154; 1943) Dr. J. D. Rolleston directs attention to the large number of synonyms for epilepsy, many of which are popular terms, alike in Ancient Rome, the Middle Ages, and Bavaria in recent times. The English term 'falling evil' or 'falling sickness', which corresponded to the Latin *morbus caducus*, was for a long time prevalent but has now become obsolete. The chief folk-lore cause for epilepsy, which is still held by primitive races, was demoniac possession. Many examples of this belief have been found not only in the ancient Babylonian and Assyrian texts and the literature of ancient Greece and Rome, the Bible and the Talmud, but also in the West Indies, West Africa, Patagonia, Siberia, India, Ceylon, China and elsewhere (Tylor and Frazer). Another factor in the folk-lore causation of epilepsy was an astrological origin and the moon in particular. Moreover, the state of the moon was responsible in popular estimation not only for the occurrence of epilepsy but also for the efficiency of treatment.

As regards prophylaxis of epilepsy, in accordance with the rule in medical folk-lore, preventive methods in epilepsy were much rarer than curative treatment, and can be classified into external and internal applications derived from animals or plants. Treatment consisted in remedies of human origin such as blood, umbilical cord or placenta by mouth. Animal remedies took the form of their flesh, blood, milk, rennet, bile, lung, urine, testes or dung and were administered most frequently by mouth, but were sometimes made up into a plaster, liniment or amulet; plant remedies consisted of mistletoe, elder and roots and seeds of the pæony, and mineral cures were represented by precious stones, silver coins and lead. There are numerous examples on record of the supposed transfer of epilepsy to other persons, animals or plants. Other methods of treatment were charms, invocation of patron saints and miscellaneous cures, which included mock burial, castigation of the patient to drive out the supposed evil spirit, venesection and inhalation of tobacco smoke.

Simplified Subscribers' Telephone Sets

An article by E. S. McLarn (*Elect. Comm.*, 21, No. 1; 1942) describes designs which represent the first successful attempt at evolving a type of subscriber telephone set in which the components are designed and co-ordinated logically with the view of achieving simplified installation, maximum reliability and economy in maintenance. The improvements resulted from lengthy and intensive study of subscriber set behaviour in the International Telephone and Telegraph Associate Telephone Companies, operating under the most diverse conditions. Maintenance cost could be lowered if repairs were reduced to a simplified error-proof mechanical operation, for less skilful help would be required and the training period curtailed. An analysis of telephone set troubles under all kinds of climatic conditions shows that the causes are due principally to (*a*), excess moisture, dirt, lint and insects, and (*b*), open- and high-resistance circuits brought about by deteriorated soldered joints, broken conductors and poor contact between conductors and screw-heads.

The improved features of the new telephone sets introduced as a result of the investigation may be summarized as follows: complete unit mounting of components; no loose wiring; screw connexions throughout and absence of soldering; gravity switch a single unit, and integral with the base assembly, being readily accessible for adjustment; dial mechanism and gravity switch springs protected from dust, lint, insects, etc.; all spring contacts double-connected in parallel; gravity switch springs operated by a bronze roller; simplified tamper-proof ringer; induction coil and condenser sealed in bakelite cases; cellulose acetate sheet and plastics used instead of paper, fibre and textile insulation; new tipless cord which is easier to connect, prevents error, is more durable, snarl-resistant, and cheaper to use; components of entire set replaceable with a screwdriver by unskilled repair men and impossible to assemble incorrectly; rust-resisting steel base plate of sufficient thickness to prevent thread stripping.

Electrical Installations in Hospitals

A paper on this subject read recently in London by F. Charles Raphael before the Institution of Electrical Engineers reviews the considerations which apply more particularly to hospitals than to other public buildings. For permanent work, paper-lead cable is recommended for the circuits to the fuse-boards and wiring in conduit for the sub-circuits. Under-floor ducts are not recommended for hospital wiring. Suggestions are made regarding the selection of accessories and fittings. For general ward lighting a comparatively low value of horizontal illumination is recommended, with local lighting at the beds. Capacitance dimming is described, the future use of fluorescent lamps is discussed, and the shadowless lamp for operating-table lighting is described. Precautions to be taken against explosions in operating theatres are referred to and the requirements for screening in connexion with high-frequency (diathermy) apparatus necessitated by war conditions are reviewed, the opinion being expressed that regulations for this will be continued after the War. The precautions necessary in the construction and use of apparatus for electric therapy are discussed, developments in X-ray apparatus are dealt with and questions of voltage-drop and shielding are briefly mentioned. On ultra-violet treatment, the opinion is expressed that the mercury lamp, possibly supplemented by ordinary tungsten filament lamps, should eventually entirely displace the more expensive arc-lamp treatment and that there is no need to aim at an artificial reproduction of sunlight. Other subjects which are dealt with briefly are infra-red rays, cardiograph wiring, heating, ventilation of operating theatres, water supply pumps, cooking, refrigeration, lifts and signalling circuits.

Tuberculosis in Peru

The following results as to the incidence of tuberculosis in Peru were recently obtained by Dr. Ricardo Martinez of Lima (*J. Amer. Med. Assoc.*, Oct. 24). A positive index to tuberculin was found in 68·45 per cent of conscripts, 65 per cent in school children of the Callao province, 77·98 per cent among the applicants for entrance to the University of Lima, and 5 per cent in the various groups of teachers and unions of workers. The proportion of positive reactions to tuberculin in conscripts from coastal areas was 74·64 per cent, 58·43 in those from the mountains and 75 per cent in those from wooded regions. The positive results to tuberculin are higher in Peru than in the Argentine, Brazil, Paraguay and Uruguay, and less than in Cuba and Venezuela. X-ray examinations of school children show that active tuberculosis increased from 4·1 per cent in 1938 to 5·3 per cent in 1941.

Bibliography on Management and Labour

The Sheffield City Libraries have issued as Research Bulletin No. 7 a select bibliography on management and labour. This covers approximately the period 1932–42, the periodical references being, however, limited mainly to periodicals which are available in the Commercial and Science and Technology Libraries at Sheffield. Books not easily consulted or obtained have also been excluded, but some older classic books have been included, such as F. W. Taylor's "The Principles of Scientific Management". These limitations somewhat diminish the value of an otherwise excellent compilation, for there are a number of excellent modern books such as T. N. Whitehead's "Leadership in a Free Society", C. I. Barnard's "The Functions of the Executive", F. J. Roethlisberger's "Management and Morale" which cannot be excluded on these grounds, and the omission of reference to any of the works describing the important investigations initiated by Elton Mayo at the Western Electric Co. is a serious defect. References to readily accessible pamphlet literature, especially that issued in Great Britain during the War, are also incomplete. Owing to the paper shortage, copies cannot be supplied to individual students, but are available to firms and research organizations on official application, with which 3*d.* should be enclosed to cover postage.

Announcements

Prof. A. C. Chibnall, professor of biochemistry in the Imperial College of Science and Technology, has been appointed Sir William Dunn professor of biochemistry in the University of Cambridge, in succession to Sir Frederick Gowland Hopkins (see Nature, April 10, p. 415).

Dr. E. D. Hughes, lecturer in chemistry at University College, London, has been appointed professor of chemistry at the University College of North Wales, Bangor.

The following appointments and promotions have recently been made in the Colonial Service: P. C. Owen, assistant conservator of forests, Sierra Leone; J. S. Webb, mineralogist, Nigeria; R. A. Hutchinson, veterinary officer, Gambia; N. V. Rounce, district agricultural officer, Tanganyika Territory, to be senior agricultural officer, Tanganyika Territory.

The Academia Nacional de Medicina of Buenos Aires has recently established the Hirsch Medical Scholarship with a fund of 500,000 pesos (about £30,000) given by Mr. Alfredo Hirsch, of Buenos Aires. Selected students will follow medical studies in the United States or Great Britain for two years, beginning in the middle of 1943. For the first ten years the scholarships will be given for studies on cancer, leprosy and infantile paralysis.

Erratum. In the article in Nature of May 1 on "Cultivation of the Douglas Fir in Great Britain"; on p. 493, col. 1, line 17, the word "and" is superfluous; *Pseudotsuga Douglasii* and *Ps. taxifolia* are alternative names for the same tree.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Anoxæmic Changes in the Liver, with regard to the 'High-Altitude' Death' of Airmen

IN recent papers Büchner[1] and his disciples Pichotka[2], Müller and Rotter[3], as well as Hesse[4], have described peculiar histological findings in livers of airmen who died under the effect of atmospheric conditions at a high altitude. The pictures under consideration consist in the formation of big, round or polyhedric vacuoles in liver cells nearest the acinus centres; these vacuoles do not contain either fat or glycogen; they appear as optically empty spaces, including here and there a crescent-like hem of slightly acidophil, homogeneous material, probably serous liquid.

Corresponding changes could be produced in guinea pigs and rabbits under atmospheric conditions similar to those at high altitude by keeping the animals in low-pressure chambers under normal pressure but reduced oxygen content of the respiratory air.

Reviewing post-mortem material from recent years, Hesse has found identical liver alterations in cases where death had occurred in the course of an acute anoxæmic crisis, as for example, suffocation or drowning, etc.

These findings are important not only from the diagnostic point of view, where they may make possible the diagnosis of 'anoxæmia' by histological methods alone, but from the theoretical point of view as well, for, in combination with physiological methods, they may lead to a new understanding of the results on cell function of reduced or interrupted oxygen supply.

So far, no physiological studies on this special question seem to be available.

In the course of earlier systematic studies on the influence of phosphorus and chloroform poisoning on 54 guinea pigs, we have examined (together with Bueding[5]) the histological features as well as the formation of glucuronic acid of liver tissue, the latter by the method of surviving slices in the Barcroft-Warburg apparatus.

Among the poisoning experiments, generally performed by injection of the toxic compounds, there were but two, where the animals were held in deep, reflexless, chloroform inhalation narcosis for 3·5 hr., after which one of them agonized and was killed by a blow from behind; the second one was killed at the same time having shown no abnormal clinical behaviour.

Both the livers presented histologically exactly the picture as described above. Although at that time we had no knowledge about its possible significance, we noted the peculiarity of the alterations as something unusual, particularly as we have seen no similar features at any time before or after it. Only when reading the above-quoted papers, we became aware of the possible meaning of the changes concerned, particularly as a status of rather pronounced anoxæmia in the animals was safely to be assumed.

The physiological studies were based on the facts shown first by Bueding and Lipschitz[6] that surviving liver tissue possesses the conjugated faculty of forming glucuronic acid in the presence of incombustible alcohols like (0·1–0·25 per mille) borneol or (0·08–0·2 per mille) menthol in a saline phosphate medium; the same authors were able to show, too, that contrary to earlier assumptions, the glucuronic acids are the products of a biological synthesis of triose-alcohols where the synthesis of carbohydrates and that of glucuronic acids are concomitant reactions, the latter occurring, however, only when alcohols of the borneol type are present (which have to be detoxicated). The starting products for these syntheses being triose-alcohols of half-acetal character like lactic acid (or pyruvic acid); the formation of conjugated glucuronic acids is significantly increased by the addition to the saline medium of one of them (for example, 0·02 *M* sodium lactate), provided the liver tissue shows its normal physiological (and, therewith, catalytic) faculties.

In both our livers we have found under such conditions scarcely any changes, indeed, as compared with the behaviour of normal control livers.

We feel, therefore, justified in concluding that, under acute anoxæmic conditions in guinea pigs, at least one of the important functions of liver tissue, closely related to the carbohydrate metabolism, remains intact; further and more specially directed studies have to find out how other basic functions behave under similar conditions.

The accompanying table gives (*a*) the data of the experiments in question as compared with (*b*) results from 20 normal controls and (*c*) with those from 10 guinea pigs poisoned with phosphorus:

		Mgm. glucuronic acid produced by 1 gm. of dried liver	
		Saline containing 0·01 per cent borneol	Saline containing 0·01 per cent borneol and 0·02 *M*. lactate
(*a*) 2 guinea pigs 3·5 hours in chloroform narcosis ('anoxæmic livers')	Limits	3·8—3·9	5·0—7·5
	Average	3·85	6·55
	Average increase		+ 65%
(*b*) 20 normal controls	Limits	1·1—5·4	1·7—11·4
	Average	2·85	5·05
	Average increase		+ 77%
(*c*) 10 guinea pigs poisoned with phosphorus (0·75 mgm. yellow P per 100 gm. animal weight)	Limits	0·25—3·8	0·25—4·9
	Average	1·8	2·0
	Average increase		+ 11%

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(Chief of Laboratories).

Institute of Experimental Pathology,
University of Istanbul.
Jan. 30.

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[1] Büchner, F., *Klin. Wschr.*, 721 (1942).

[2] Pichotka, J., *Zieglers Beitr.*, **107**, 117 (1942).

[3] Müller, E., and Rotter, W., *Zieglers Beitr.*, **107**, 156 (1942).

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[6] Lipschitz, W., and Bueding, E., *J. Biol. Chem.*, **129**, 333 (1939).

[7] Bueding, E., and Ladewig, P., *Proc. Soc. Exp. Biol. and Med.*, **42**, 464 (1939).

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Nutritional Requirements of *C. diphtheriae* and *L. casei*

THE investigations of Lythgoe, Macrae, Todd and others[1] upon rat growth-factors present in liver extracts, and those of Evans, Handley and Happold[2] on the nutrition of *C. diphtheriæ* (types *intermediate* and *gravis*), established the identity of a common growth-factor in these extracts with pantothenic acid. The former investigators also established the presence of another rat growth-factor (factor β) in the amyl alcohol-insoluble fraction of acidified liver concentrates. Active preparations of this factor were found to promote the growth of certain intermediate types of *C. diphtheriæ*, and in 1940 Happold, Lythgoe and Todd commenced a joint investigation with the object of elucidating its nature. The factor could not be extracted by amyl alcohol from aqueous acid solution or by butanol from alkaline solution. At *p*H 1 it was not adsorbed on fullers earth but was readily adsorbed on charcoal (Norite), from which it could be eluted with acetone-ammonia-water. Treatment with 20 per cent hydrochloric or sulphuric acids at 100° for two hours caused little diminution in activity, but similar treatment at *p*H 11 (sodium hydroxide) caused almost complete inactivation. Complete loss of activity was also caused by acetylation, methylation or treatment in the cold with nitrous acid. The growth-factor was not precipitated by phosphotungstic acid, and attempts to purify further via the lead salt were inconclusive, much activity being lost in the process.

More recently, further progress has been made by Chattaway, Happold and Sandford using as test organisms strains of *C. diphtheriæ gravis* of a type at present prevalent in Dundee and obtained through the courtesy of Prof. W. J. Tulloch. The growth-factor for these strains has properties identical with those established for the intermediate type factor, but some additional facts can be given. It is readily adsorbed on Norite at *p*H 3 and 9 but seems less readily adsorbed at *p*H 6·5–7. It cannot be replaced by biotin nor is its activity reduced by avidin, and its properties appear to differentiate it from folic acid; it is insoluble in ethanol and in common organic solvents. The activity of concentrates is largely destroyed on boiling for fifteen minutes with ninhydrin in one third saturated potassium dihydrogen phosphate. It is not extracted by *p*-cresol from acid aqueous solution at *p*H 3; this differentiates it from a growth-factor for *Lactobacillus casei* ε the properties of which had, until this observation was made, appeared to identify it with the *C. diphtheriæ* factor. Another point of difference between the two has been found in the observation that the *L. casei* factor is precipitated as a silver salt at *p*H 7 while the *C. diphtheriæ* factor remains in solution.

It is our intention to publish elsewhere fuller details of the associated studies in our two laboratories, but in view of the general interest in this type of investigation we feel that the position of the work should be indicated at this time.

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April 28.

Macrae, Todd, Lythgoe, Work, Hind and El Sadr, *Biochem. J.*, **33**, 1681 (1939); Lythgoe, Macrae, Stanley, Todd and Work, *ibid.*, **34**, 1335 (1940).

Evans, Handley and Happold, *Brit. J. Exp. Path.*, **20**, 396 (1939).

Rumex Lunaria L., a Gynodiœcious Tetraploid Species

THE genus Rumex is divided by modern taxonomists[1] in three sub-genera: Lapathum, Acetosa and Acetosella. In the sub-genus Lapathum only hermaphroditic species occur, but in the other two sub-genera diœcious forms are met. According to studies on the mechanism of sex determination met in these two latter sub-genera, the sub-genus Acetosella belongs to the Melandrium type of localization of sex-determining genes, that is, the *Y* possesses strong male elements, which may dominate over all the female elements in the *X*'s and autosomes in the tetraploid, hexaploid and octoploid species of the subgenus[2,3]. The diœcious species of the sub-genus Acetosa, however, are found to belong to the Drosophila type of localization of sex-determining genes, that is, the *Y*'s are inert, and the sex is determined by a balance between the *X*'s and the autosome sets[4,5,6]. This latter mechanism prevents polyploidy, as shown by Bridges[7], Muller[8] and Ono[4]. The diœcious plants of the sub-genus Acetosa belong to the section Euacetosæ, but in the section Hastati polygamodiœcious and gynodiœcious species are met[3]. Hermaphroditic plants are met in other sections of the sub-genus, namely, Scutati and Vesicarii. Polyploidy has hitherto been known only within the British forms of the collective species *R. scutatus*[9].

According to an explanation given by Löve[3] on the evolution of the two different types of localization of sex-determining genes in the two sub-genera of Rumex, these are to be regarded as two fundamentally different lines of evolution. The type met in sub-genus Acetosella has evolved from hermaphroditic individuals by mutations in the *male* direction followed by chromosomal recombinations over the polygamodiœcious and *androdiœcious* state to the present diœcious state. The type of sub-genus Acetosa has evolved by mutations in the *female* direction from hermaphrodites over polygamodiœcious and *gynodiœcious* plants to the diœcious ones met in section Euacetosæ. According to this hypothesis, the polygamodiœcious and gynodiœcious species of section Hastati should be regarded as a younger state in the same evolution process as the diœcious forms of section Euacetosæ. When the process has evolved to the diœcious state, polyploidy will result in intersexual, sterile forms and in females, as found in the species *R. Acetosa* some few times[4,5,6], but if a polygamodiœcious or gynodiœcious species will become polyploid, no differences in its sex form will, theoretically, be observed. Its way to the diœcious state will, however, be practically blocked.

During the last four years, I have made a number of investigations on the cytogenetics of different species of the genus Rumex. One of the forms examined was the gynodiœcious *Rumex Lunaria* L., which is a Macaronesian species of section Hastati, often cultivated in botanical gardens. My material was obtained from the Botanical Gardens in Lisbon, Portugal, and it is of the same type as herbarium material from the Canaries found in the Botanical Museum at Lund, Sweden.

The only species of the section Hastati hitherto studied, *R. hastatus* D., showed the diploid chromosome number $2n = 18$ [10]. The chromosome number of the species *R. Lunaria* L. was, however, $2n = 36$, or the tetraploid one.

As expected from the above hypothesis, the hermaphrodites of *R. hastatus* and *R. Lunaria* represent the heterogametic sex, giving after selfing a number of hermaphrodites and some females. After a pollination of a female with pollen from a hermaphrodite plant about 50 per cent hermaphrodites and 50 per cent females are obtained.

The tetraploid plants show a very great power of vegetative propagation, which is not met in my material of other species of Rumex, as cuttings may be taken from different parts of the plant.

Although it is not very likely that this tetraploid form has arisen from a diœcious or almost diœcious form with the same type of sex determination as met in *R. Acetosa*, it is not a fully excluded possibility. All tetraploid intersexual types of *R. Acetosa* are, however, almost completely sterile, while the hermaphroditic plants of *R. Lunaria* show an almost complete fertility. If experimentally produced tetraploids of, for example, the diploid gynodiœcious species *R. hastatus* will be found to be gynodiœcious, it must be regarded as a good support to the suggestion that the tetraploid *R. Lunaria* originates from a gynodiœcious diploid, and it would also give strength to the above-mentioned hypothesis on the two different lines of evolution of sex mechanisms in the two groups of the genus Rumex.

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March 19.

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Polygenes in Development

IN criticizing my conclusions[1] regarding the relations between polygenic buffering systems and oligogenic switching, or key, systems, and in considering the advisability of dispensing with the term polygene, Dr. Waddington[2] rests his case on three main points, namely :

(1) That switching systems may depend on the joint action of a number of genes each of relatively small effect and so cannot be considered to be distinct from other systems of genes each of small effect.

(2) That many genes are known to have large main effects combined with smaller secondary effects, so leading to the conclusion that a gene may simultaneously determine oligogenic and polygenic variation.

(3) That genes producing "very minor changes in a character must be acting as rather ineffectual buffering agents on the last phases of its development".

Let us consider these points further.

The first begins with a statement which is true—so far as it goes. But such jointly acting genes cannot constitute a switching system which is efficient, and hence able to survive the test of natural selection, unless they are completely linked and segregate a unit. They will thus jointly act, and will appea genetic analysis, as one gene of large effect, that as a major gene, not as polygenes. This is in one of the ways in which I envisaged the evolut of switching genes from polygenes in the discuss which is being criticized.

The second point is also true so far as it conce the manifold action of some genes. But can secondary effects of such genes be regarded as de *mining polygenic variation ?* The polygene not was developed (see ref. 3) in relation to the actior selection, both in experiment and in Nature. Natu selection must act on the total phenotypic effect a gene, and hence genes of the kind Wadding considers will be selected almost entirely on th drastic main effects. Their secondary effects can thus give rise to polygenic variation of the k which I have discussed. Nor can it be suppo that natural polygenic variation is of this second kind. It is rarely if ever associated with any dete able major effects, and such association would sur have been detected in a proportion of cases intensively investigated organisms, like Drosoph maize or man, were it a regular feature of system.

Thirdly, we have the statement that genes caus "very minor changes" are "rather ineffectual buff ing agents". This, however, misses the essent point that small gene changes can accumulate selection without mechanical limit. Though effect of one gene change may be minor, a numl of them acting in aggregate can be far from effectual ; and, in accumulating, such changes provide just that fine adjustment which is requis in a buffering system, and which cannot be p vided by the mutation and recombination of ma genes.

In conclusion, I must mention Waddingto equation of polygenes to Nilsson-Ehle's polyme genes. The latter are defined only by similarity action to one another, whereas the former are fined also by the magnitude of their individual effec which are small when compared with the total no heritable fluctuation[1,3,4,5]. Nilsson-Ehle's origin polymeric genes in wheat and oats had effects mu larger than non-heritable fluctuation (or he cou not have scored them individually by the Mendeli technique) and so cannot be regarded as polygen They were polymeric only by virtue of the allopol ploidy of these cereals, and it was this accident circumstance which provided the basis for inte preting quantitative inheritance. It is indeed mo important to recognize that major genes, as well polygenes, can show polymeric action, and that doing so they do not become polygenes.

Polygenes, as I have derived the notion from m experiments, are distinct from major genes and mu play a different part in the selective adjustment development.

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London, S.W.19.
April 8.

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A Light Effect in Chlorine under Electric Discharge: Influence of the Intensity and Frequency

FURTHER work on the diminution of the current which occurs on irradiation of chlorine[1,2] has shown that several factors, some mutually exclusive, determine the magnitude of the phenomenon, such as the various electrical quantities; the electrode spacing, area and 'ageing' under the discharge; the nature of the gas, its temperature and especially the pressure. The chief difficulty in ascertaining the optimum conditions for the effect was that more than a limited variation of one of these altered others so much as to reduce the comparability of results. Furthermore, there was a limit to the influence of any of them on the decrease of current; for example, within a restricted pressure range and at a given applied potential, it increases to a maximum with decrease of pressure; it is negligible when the pressure is small. A similar limiting effect obtains with increase of applied potential at constant pressure.

Detailed studies of the above factors showed that a large Siemens' ozonizer, irradiated transversely and filled with about 11 c.c. of chlorine, was a fairly representative condition within the limitations of the electrical supply and especially the sensitivity of the available, oxide-rectifier type A.C. indicator. With a 50-cycle frequency, $v = 9{,}000$ volts (r.m.s.); a deflexion of 54 served to indicate the current. On irradiation by the carbon arc, the current decreased by 20–21 or about 38 per cent (see table); the decrease in the green and red was too small to measure accurately.

DECREASE OF CURRENT ON IRRADIATION

Light source \ Wave-lengths	White (7800–3700 A.)	Violet (4750–4000 A.)	Green (5775–5070 A.)	Red (7070–6070 A.)
200-watt bulb ..	10	8	0·5	1
Mercury arc ..	18	16	1	
Copper arc ..	9	7	0·5	
Carbon arc* ..	20	21	1	1
Iron arc* ..	20	20	1	0·5

* Due to the unsteadiness of these arcs, the comparative intensity conditions were not constant.

The effective frequency of irradiation was varied by use of coloured glass strips, instead of the Wratten or similar filters, due to the size of the ozonizer. It was limited on the short wave-length side at about 3700 A. due to glass absorption. The intensity I was determined with a sensitive thermopile, a photoelectric cell and the corresponding spectrum. I_{green}, n green was very low with all the sources used; his accounts for the corresponding decrease in current. With the bulb, the carbon and iron arcs, the decrease in the red is similar to that in the green. When, however, I_{red} was made comparable with ${}_{\text{green}}$, the decrease in current due to the former was sensibly smaller and appeared attributable to the corresponding frequency difference. This factor also xplains the comparatively large current decrease in the violet, although it is the narrowest of the bands employed; that this falls within the characteristic absorption of chlorine, namely, 2300–5000 A.[3,4] may well be an additional and important cause. It is interesting to note that the current decrease due to iolet is comparable with that for the unfiltered, that is, white light, where the total intensity is much greater.

The absorption coefficient of chlorine increases rapidly with frequency and is 65·5 at the band head, namely, 3340 A. Its values at the short wavelength limits for the violet and the unfiltered white, namely, 4000 A. and 3700 A., are about 5 and 19 respectively[3,4]; the corresponding growth of current decrease with frequency, however, is not of the same order (see table). A like result suggestive of saturation or some limiting condition is revealed by observations, over a wide intensity range of the ratio, of current decrease in white to that in the violet. This diminished from about 2 to 1 as the intensity was increased 2,200 times.

The above work was intended to form part of a comprehensive report of work, in progress since 1939, on what would appear to be a new photo-voltaic phenomenon in chlorine and other gases[5,6]. Some typical results are indicated here, since it appears doubtful whether the work can be completed under present conditions.

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P. G. DEO.

Chemical Laboratories,
Benares Hindu University.
Feb. 19.

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The Hydrogen Bond and its Influence on Acid Strength

QUANTUM mechanical resonance is undoubtedly a determining factor in deciding acid strength in certain cases, and empirical relations sometimes exist between the number of possible resonance structures (taken as a measure of the resonance energy) and the logarithm of the dissociation constant[1].

The strengths of salicylic acid and 2 : 6 dihydroxybenzoic acid will be discussed here. There is first of all the difficulty of accounting for their strengths in terms of ions or dipoles, bond lengths, angles and simple electrical theory. An elementary analysis of the problem using the concept of electrostatic potential at the carboxyl ion, which is assumed to govern log K, indicates that both acids have abnormally high ionization constants compared with benzoic acid. Also inspection shows that the two acids have similar strengths to chloracetic and dichloracetic acids, the ionization constants of which have already been accounted for on the resonance hypothesis.

Now it has been recognized for some time that internal hydrogen bond formation takes place in these phenolic derivatives[2] which is stronger in the ion than in the undissociated molecule, appreciably diminishing the proton capacity. It was thus of interest to see whether any relation existed between the number of resonance structures (n) (taking into account the hydrogen bonding) which could reasonably be formulated for these acid ions and the free energy of ionization. The accompanying table contains the relevant data, K being the thermodynamic ionization constant. With $n = 1$, we are dealing with a non-resonating carboxylic group containing compound of very low acid strength.

Acid	K	$5 + \log K$	n
Non-resonating carboxyl group	10^{-10}	0·00	1
Benzoic acid	$6{\cdot}27 \times 10^{-5}$	0·80	3
Salicylic acid	$1{\cdot}05 \times 10^{-3}$	2·02	6
2 : 6 acid	6×10^{-2}	3·8	12

A hypothetic salicylic acid, having $n = 3$ (neglecting the Kekulé resonance), would have an acid strength approximately equal to that of benzoic acid. The actual salicylic acid ion has $n = 6$ with three additional structures resulting from hydrogen bonding, and the di-ortho acid an additional six structures, making $n = 12$. An equation such as the following may be suggested:

$$5 + \log K = a(n - 1),$$

with $a = 0{\cdot}36$. So far as is known, no other attempt has been made to link up these acid strengths quantitatively. Others will, it is to be hoped, improve on it.

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Bradley, Bilston,
Staffs.
April 21.

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[2] Branch and Yabroff, *J. Amer. Chem. Soc.*, 56, 2568 (1934); Baker, W., NATURE, 137, 236 (1936).

X-ray Wave-lengths : Notation

It appears that future confusion could be avoided, and a considerable amount of space saved, if there were some short way of showing that a particular measurement was referred to the Siegbahn scale, and not intended to be absolute. Adoption of the suggestion of Lipson and Riley[1], that inaccurate measurements should be given in Ångstrøms and accurate ones in X-units, seems undesirable for two reasons. First, it might give the impression that the absolute accuracy of X-ray measurements is of the order of 0·1 per cent, not 0·001 per cent. Secondly, it is tacitly agreed among crystallographers that a unit about the size of the Ångstrøm is much handier than the X-unit. May I suggest that measurements based on the Siegbahn scale be denoted by 'kX.'? The symbol is short, and expresses fairly obviously that the measurement is in thousands of X-units. Thus the lattice parameter of iron (to use Lipson and Riley's example) would be expressed as 2·86 kX. or 2·8604 kX., the increase in accuracy not requiring a change in the unit.

A. J. C. WILSON.

Cavendish Laboratory, Cambridge.
May 3.

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[1] Lipson and Riley, NATURE, 151, 502 (1943).

Control of Chemical and Mineral Products

As some aspects of the proposals made in my recent speech to the Parliamentary and Scientific Committee appear to have been misunderstood[1], may I clarify the matter in the following ?

(1) It was envisaged that the rope of security would be many-stranded. We cannot rely on any one method as sufficient in itself.

(2) The only specific proposal I made was that the implications of technical disarmament should be studied in detail in advance.

(3) As an example I tried to establish a *prima facie* case for the inclusion of nitrogen products control by the United Nations among the topics to be studied.

(4) In the course of (3), I stated that, in my opinion, the arrangements would necessarily be such that *at no stage* would Europe, including Germany, be deprived of nitrogen products required for agriculture and peaceful industry.

In a subsequent memorandum to the Parliamentary and Scientific Committee, the whole emphasis was laid on the need for detailed investigation of the problem and I am quite satisfied with the outcome.

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[1] See NATURE, April 24, p. 455.

The Royal Aircraft Establishment, Farnborough

CRITICISM has been recently made of the work of the Royal Aircraft Establishment at Farnborough, Hants. This institution was known during the War of 1914–18 as the Royal Aircraft Factory and prior to that as the Balloon Factory where, in 1905, Mr. S. F. Cody began glider experiments on the adjacent common. Chemists in the Royal Aircraft Establishment still use the door on which can be traced the wording, Balloon School, and the laboratories were once used by women who pieced together goldbeater skins for making the linings of balloons and the early airships. These laboratories were used during 1914–19 by Lord Cherwell (then Dr. Lindemann) and by Dr. F. W. Aston.

In all fairness to the large scientific and technical staffs in the Establishment, much excellent work has been done, is being done, and we trust will continue to be done with ever-increasing scope. In the past there has been a steady stream of trained men whether trade or engineering apprentices or staff from the R.A.E. into important posts in the aircraft industry.

Looking back over twenty-five years of work in the Royal Aircraft Establishment, I do feel that my colleagues have contributed something substantia and important to aeronautical science and incident ally to pure science in the form of scientific papers on combustion, rheology, metallurgy and corrosion etc. To attract and keep the best staff, it is obviously necessary, as indicated in the sixteenth report of the Select Committee on National Expenditure, tha there be better remuneration and better prospect for the scientific and technical personnel. The chie designer, Royal Aircraft Establishment, is being established as an Assistant III (Carpenter Scale) and his salary is but a three figure one. A similar state of affairs applies to the chief metallurgist or head chemist, and this low remuneration and status exis towards the close of a long, useful career.

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RHEOLOGY OF RUBBER

RUBBER is one of the many materials of great industrial importance the physical properties of which have not yet been precisely formulated, with the result that, although the word 'elastic' has become in everyday usage almost synonymous with 'rubber', the standard text-books on elasticity, if they refer to rubber at all, leave the impression that it is little more than a scientific curiosity.

Evidence that this state of affairs is rapidly passing was forthcoming from the large gathering of scientific men and technologists at a joint conference of the local section of the Institution of the Rubber Industry and the British Rheologists' Club, held in Manchester on April 17, to discuss some of the rheological problems of the rubber industry. At the morning session, at which Mr. W. N. Lister (I.R.I. local secretary) presided, papers were given by Dr. L. R. G. Treloar (British Rubber Producers' Research Association), Messrs. J. M. Buist and R. C. Seymour (Rubber Service Laboratories of I.C.I. (Dyestuffs) Ltd.) and Dr. J. R. Scott (Research Association of British Rubber Manufacturers).

In the first paper of the morning, Dr. Treloar dealt with "The Behaviour of Rubber in Elongation, Compression and Shear". His object was to show how these three simple types of deformation can be produced, and to consider the corresponding stress-strain relations, both from the experimental side and from the point of view of the molecular theory. His treatment referred only to well-vulcanized rubber, which can be regarded, at least approximately, as ideally elastic.

Dr. Treloar said that the fundamental reason for the high degree of elasticity of rubbers is to be found in the thermal motion of the chain atoms composing the very long molecules of which they are composed. This 'kinetic' theory shows that an assembly of molecules will take up a certain normal distribution of lengths which can be calculated by statistical methods, in much the same way as the molecules of a gas acquire a definite distribution of velocities. Any deformation of rubber disturbs this normal distribution, and hence leads to a less probable state. By considering an idealized network of cross-linked molecules Wall (*J. Chem. Phys.*, 10, 485; 1942) has recently shown how the molecular distributions corresponding to elongation, uni-directional compression or shear may be described, and has calculated the probability of the distribution corresponding to any given state of deformation. By thermodynamic reasoning the probability has been related to the entropy, and this in turn to the work of deformation. The stress-strain relations are derived from the expression for the work of deformation.

The conclusions to be drawn from the molecular network theory are that rubber should obey Hooke's law in shear, though not in elongation or compression. Wall showed also that the stress-strain relations for elongation and compression should form a single continuous curve. An interesting feature of Wall's formulæ is that the description of all three types of behaviour require the use of only one molecular constant, *M*, defined as the 'molecular weight' between junction points of the network. These conclusions are very illuminating, and must be regarded as of fundamental importance.

Dealing next with his experimental work, Dr. Treloar said that in comparing the experimental stress-strain relations with the theory it is desirable to use the same sample of rubber for the different types of deformation. He showed by practical demonstrations that a circular sheet of rubber clamped round its circumference can be inflated into a balloon, giving a 2-dimensional extension which is equivalent to a compression. A pure shear can be produced by applying a tension to a short wide strip of rubber gripped in wide clamps. The experimental stress-strain data for elongation and shear are found to be in agreement with Wall's formulæ when the deformations are not too large, but depart from them noticeably at higher deformations (for example, above 100 per cent elongation). For the compression the agreement is much closer. It is satisfactory to find that all three types of deformation lead to the same value of *M*.

Dr. Treloar believes that the experimental evidence shows that the basis of Wall's theory is substantially correct, but that modifications of it may be necessary to take account of certain properties of the molecules which the theoretical treatment does not at present include.

The second paper dealt with "The Position of the Rubber-like State on the Plastic-elastic scale". Mr. Seymour, who read the first part of this paper, began by referring to the classification of types of deformation put forward by the British Rheologists' Club (NATURE, 149, 702; 1942), which represents a type of scale in which ideal elasticity occurs as one extreme and Newtonian viscosity as the other. Rubbers occupy an intermediate position, being either visco- or plasto-elastic. But rubbers are not adequately described simply as being intermediate between solids and liquids, for whereas Hookean solids and Newtonian fluids can be described by single physical constants, the characteristics of rubber-like materials depend upon strain and upon rate of strain. Thus, representation of the behaviour of rubbers requires more complex functions relating the three variables stress, strain and time.

The deformation of rubber in compression can be described by an equation of the Nutting–Scott Blair type, relating the shear σ with the shearing stress S and time t, namely:

$$\sigma = \frac{1}{\psi} S^{\beta} t^{k}.$$

For rubbers, β is approximately 1·0. There are thus two constants for a given material, ψ and k, which can be determined experimentally, and can be regarded as characteristic of a given rubber. A diagram can be drawn, in which k is plotted horizontally and ψ vertically, to represent the rheological properties of different rubbers.

For rubbers in extension an equation was proposed of the form

$$\psi' = S\dot{\sigma}^{-k'}\sigma^{k'-1},$$

which takes account of rate of strain ($\dot{\sigma}$).

The second part of the paper, read by Mr. Buist, included experimental data which show that the equations given above represent the behaviour of natural and synthetic rubbers. A study of a number of rubbers reveals that those having low values of k are relatively difficult to mill. Natural rubber is the most easily milled, and has the highest k value. Continued milling reduces ψ (that is, the rubber becomes more plastic), and the spread of k values for different rubbers is reduced, the lowering of k for natural rubber being attributed to oxygen vulcanization.

Vulcanization moves all rubbers towards the elastic end of the scale, giving lower values of k. An 'index of reinforcement' was defined as the ratio of k before and after compounding and vulcanization. For natural rubber this index is higher than for synthetics. This is reflected in the greater difficulty experienced in vulcanizing the synthetics. The movement toward the elastic end of the scale was demonstrated by analysis of the partial vulcanization (that is, 'scorching') of rubbers in terms of ψ and k values.

Values of ψ' and k' in the case of extension are characteristic for each rubber, but differ from ψ and k for the same materials.

The data of Hahn and Gazdik (*India Rubber World*, **51**, 103; 1941) on the slow creep of rubbers in shear give values of k and ψ which are in accord with the performance of the engine mounting compounds described by these authors. For a given value of ψ the smallest creep is obtained with the lowest value of k.

Dr. Scott's paper, entitled "Rheological Problems in the Rubber Industry", discussed a variety of problems in which the rheological properties of rubber are of great importance, and showed how the better understanding of these properties might assist in the control of technological processes.

Dr. Scott took a different line from the previous speakers, representing the properties by a plot of $d\sigma/dt$ (rate of shear) against S (shearing stress). One can recognize specific types of flow curve, such as viscous, pseudo-viscous, plastic, etc., which can be related to the suitability of the material in any given circumstances. In the plasticization of rubber, the incorporation of filling ingredients requires first, good wetting properties, which means high fluidity under the action of small forces, and secondly, the breaking down of aggregates of filler particles, which necessitates high shearing stresses, and therefore high viscosity. These apparently opposite requirements can be satisfied by a certain type of flow curve.

The moulding of unvulcanized rubber is related to other rheological properties. The moulded article must retain its shape. This requires (1) the absence of elastic recovery, and (2) the presence of a yield value, so that the article will not deform under its own weight. The latter property can be assessed from the flow curve. Other examples of rheological significance are the coating of fabrics with rubber, which requires ready penetration into the fabric, and the building up of tyres, etc., which requires good self-adhesion, and means the flowing of one rubber surface into the other. Vulcanization represents the suppression of flow, while reclaiming may be regarded as the recovery of the flow properties which have been suppressed by vulcanization. Methods of assessing degree of vulcanization, for example, by so-called 'permanent set' tests, and the study of reclaiming thus come within the scope of rheology.

Dealing with methods of measuring the flow characteristics of rubber, Dr. Scott discussed the Williams parallel plate plastometer, extrusion methods, and the Mooney (shearing disk) plastometer, and the sort of information which can be obtained from them. None of these methods provides a uniform rate of shear throughout the specimen, which he considers essential for the fundamental study of rheological properties. Finally, he suggested that the study of the rheological behaviour of rubbers in relation to technological processes on one hand, and to their molecular structure on the other, opens up the possibility of producing rubbers having the particular properties which the technologist may require for any given purpose.

A visit was made in the afternoon to the Rubber Service Laboratories of I.C.I. (Dyestuffs) Ltd., at Blackley, by permission of the delegate directors. Members of both societies were welcomed on arrival by Dr. W. J. S. Naunton. The principal aspects of the handling and testing of natural and synthetic rubbers were illustrated in the laboratories, by a number of demonstrations which emphasized the broad rheological field covered by rubber-like materials.

RECENT ADVANCES IN ORGANIC CHEMICAL METHODS

AT a meeting of the London and South Eastern Counties Section of the Institute of Chemistry on April 21, Dr. E. R. H. Jones, of the Imperial College of Science and Technology, gave a lecture on "Recent Advances in Organic Chemical Methods". He said that spectacular advances which have characterized contemporary organic chemistry are largely to be attributed to vast improvements in the technique of the isolation, purification, examination and synthesis of organic compounds, and both new and improved physical and chemical methods have been extensively utilized. It is ever the aim of the organic chemist to employ methods involving the mildest possible conditions and the minimum quantity of material, a trend determined principally by his growing preoccupation with labile compounds of biological importance.

Notable advances made in distillation technique are attributable to the influence of the ever-growing petroleum industry. Molecular distillation is becoming increasingly popular and has rendered possible the isolation of vitamin A in a crystalline form. Chromatographic analysis has enormously simplified the purification of both naturally occurring and synthetic organic compounds and has provided a valuable new criterion of purity. On the chemical side a number of new reagents have been developed for the separation of particular classes of organic compounds.

The contribution of microanalysis towards recent achievements cannot be easily over-emphasized, and has led inevitably to the universal introduction of micro-methods. Absorption spectroscopy has proved of great service in the isolation and determination of the structure of vitamins and hormones, and although our knowledge of the relationship between structure and light absorption is still largely empirical, a sufficient fund of information is available to give the method a high diagnostic value.

Greater selectivity can now be obtained following the discovery of hydrogenation catalysts of the Raney nickel type and more specific chemical methods of reduction, for example, sodium in liquid ammonia, and calcium-ammonia ($Ca(NH_3)_6$), are being continually developed. The Meewein-Ponndorf reaction is of unique value for the reduction of sensitive aldehydes and ketones, and Oppenauer's demonstration that this reaction can be reversed provides a useful means of oxidizing unsaturated secondary alcohols to ketones which renders unnecessary the protection of unsaturated linkages. Wide popularity has been accorded to such highly specific oxidizing agents as lead tetra-acetate osmium tetroxide and selenium dioxide.

The high-temperature nitration of paraffins and substitution chlorination of olefines are recent technical developments of great significance. The α-methylenic halogenation reaction can now be conveniently effected in the laboratory under mild conditions by employing N-bromosuccinimide. The remarkable orientating effect of organic peroxides on the addition of hydrogen bromide to olefines has led to the discovery of other chain reactions, of considerable preparative value, initiated by these trigger catalysts.

THE GRID AND SECONDARY POWER STATIONS IN GREAT BRITAIN

IN a paper entitled "The Effect of the National Grid on the Operation and Maintenance of Secondary Power Stations" read before the Institution of Electrical Engineers in London on April 1, R. A. W. Connor discusses the status and function of these stations in relation to the Grid in Great Britain, together with some of the running and maintenance problems brought about by Grid operation, and some of the factors affecting cost of production. The paper directs attention to the important part played by the secondary power stations, the efficient and economic operation of which has undoubtedly contributed in no small measure to successful Grid operation, and to the benefit of the supply industry as a whole.

The following conclusions are reached as a result of the study. The general shape of the national load curve will remain for many years and will not necessitate radical changes in station design. The reclassification of every station through its normal working life must continue, and it would be uneconomic to lay down plant or stations specifically to deal with peak loads only. Future load curves may exhibit exceptionally high rates of change of loads during certain periods, but the capacity of secondary stations will increase and it is unlikely that any new plant will have to be relegated to secondary duties until some years of primary station duties have been completed.

Improvement in the average thermal efficiency of secondary stations will continue owing to the relegation to this class of more modern stations with higher steam pressures and temperatures. There is cope for further improvements in operation and maintenance, although running conditions and high 'banking' losses impose a lower limit on station fficiency than is the case with base-load stations. Grid operation with its daily cycle of temperature hanges has affected maintenance and repair work on secondary stations, but not seriously or to the detriment of plant.

Owing to the large variations in output encountered nder two-shift, one-shift and peak-load operation, and also due to the high fixed-cost component, all station costs tend to vary in inverse proportion to the kilowatt-hour output, and comparisons need very careful interpretation to be of any value. A characteristic curve, hyperbolic in shape, correlating output and cost, can be built up for any station. Most secondary stations are called upon at varying intervals and seasons to work with very low outputs, in which region the characteristic shows a very sharp upward trend. Due to the predominating effect of running conditions on thermal efficiency and to the sharp upward trend of the unit cost at low outputs, many secondary stations have suffered reductions in thermal efficiency and increased costs as a result of Grid operation. This, however, has enabled the primary stations to operate under base-load conditions and the full financial advantages of Grid operation to be realized.

LOCATION OF INDUSTRY IN GREAT BRITAIN

THE paper on "Location of Industry" which Mr. R. G. Glenday, economic adviser to the Federation of British Industries, delivered before the Royal Society of Arts on February 10, roundly challenges current views on the location of industry, including some expressed in the Barlow Report, but his emphasis on the background of change against which the problem of industrial location should be viewed cannot fail to be stimulating, although apart from its provocativeness his paper offers little in the way of constructive suggestion. Fundamentally, Mr. Glenday reminds us, the problem of locating a country's industries and urban centres is part of the larger problem of adjusting a population to its environment, and it is the exceptional rate of growth of populations and industries during the last century and a half that has given rise to so many acute economic problems to-day. He regards the closing of the channels of international movement, following on the disappearance of the geographical frontiers of the civilized world by the first decade of this century, as the major event responsible for bringing to a close the era of democracy and free capitalism in many parts of Europe.

The problem of industrial location must be examined against this background, and Mr. Glenday argues next that the two main factors which determined the location of industry in Great Britain, particularly the move northwards in the nineteenth century, were, first, the development of the railway and steamship, coupled with the adoption of free trade, and, secondly, the development of road transport and electrical transmission in the twentieth century. With this, from 1931 onwards, was associated a re-direction of the 'growing-point' of Britain's industrial energies to home rather than to export activities. Most discussions on the location of industry tend to under-estimate the effect of such basic structural innovations, which affect the general lay-out as well as the skeleton of the economic system.

Mr. Glenday, like the Federation of British Industries, seems to be rather obsessed with difficulties, but more creative and adventurous minds may profit by his warnings without being deterred by them. He rightly directs attention to the importance—and the difficulty—of deciding which industries and occupations are essential parts of developing urban structures and which can be regarded as independent and mobile. He stresses also the vital importance of timing in industrial progress. The two main questions which require examination in regard to post-war location are first, the probable size and quality of the population involved, and secondly, the probable direction of the forces of economic evolution affecting the occupation of that population. In regard to the first, he observes that in the main the question will be the redistribution of a stationary or even a declining population; and in regard to the second, he stresses the place of services rather than industry in providing the main channels of expanding employment.

Discounting somewhat the magnitude and significance of the drift to the south of England, though rather unconvincingly, Mr. Glenday attributes this migration to improved road transport, more flexible forms of power and the diversion of our industrial energies from foreign to home trade. The tendency of the newer occupations to be in service trades and luxury products requiring elaborate packing and careful handling as well as servicing after sale has made proximity to the main market a factor of growing importance. Moreover, the pre-war trends have been almost entirely reversed during the War. Stagnant industries have revived and expanded beyond belief and other industries have been scaled down and concentrated. These changes have been accompanied by a migration of population and industrial location in a direction entirely contrary to that of the past two decades.

The primary reconstruction problem, therefore, according to Mr. Glenday, will not be so much one of choosing the regions in which the new industries are to be established, as of selecting those in which over-expanded war industries are to be contracted. The days of expansion are ended, and in a period of increasing industrial efficiency we will have our stagnant population rapidly growing older. In the near future our main industrial pre-occupation is likely to be the development of alternatives and artificial substitutes for traditional raw materials, and replacement and concentration in existing industries and production centres. Mr. Glenday concludes by emphasizing the trend towards concentration of industry, in the sense of less labour and investment for more and more work, and that questions of industrial location and the redistribution of population will be increasingly settled in consultation with the State or with the authority responsible for dealing with the lay-out and planning of our towns and countryside.

There can be no doubt as to the importance of the new factors to which Mr. Glenday directs attention, and they will require close consideration in the planning of town and countryside which will be involved in post-war reconstruction. The picture he paints, however, is one-sided. He dismisses too cavalierly the problem which the depressed areas must again present when the war production programme terminates. He ignores the opportunities which dispersal of population, evacuation, and bombing have given us, and refuses to face the central fact that location of industry cannot be left unguided in the hands of private interests. No one could pretend that the location of industry is other than a difficult and complicated problem, any more than it can be seriously maintained that the growth of our larger towns or conurbations and the concentration of industry in London and the south-east of England has not distorted the national economic structure and imposed serious handicaps on the health and social welfare of the nation. Difficulties are no excuse for inaction, and however cautiously the problem is approached, the location of industry and the redistribution of the industrial population is an essential part of the larger problem of planning the resources of Britain to afford the maximum social and economic satisfaction to the population as a whole: and of providing such services as transport, amenities and recreation, health and occupation.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, May 15

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. O. Godart: "Belgian Scientists and the War".

Monday, May 17

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. H. V. A. Briscoe: "Some New Properties of Inorganic Dusts" (Cantor Lectures, I).

Royal Geographical Society (Kensington Gore, London, S.W.7), at 5.0 p.m.—Major G. W. Morey: Kodachrome films of Algeria and Morocco.

Tuesday, May 18

Physical Society (at the Royal Institution, 21 Albemarle Street London, W.1), at 5 p.m.—Prof. E. T. Whittaker, F.R.S.: "Chance, Freewill and Necessity in the Scientific Conception of the Universe" (twenty-seventh Guthrie Lecture).

Wednesday, May 19

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—"Agriculture To-day and To-morrow", 10: Sir John Russell, F.R.S.: "Our Agriculture—its Relation to Ourselve and Others".

Institute of Chemistry (London and South Eastern Counties Section) (at the Institute of Chemistry, 30 Russell Square, London, W.C.1), at 6 p.m.—Dr. J. W. Cuthbertson "Recent Advances in Electro-Metallurgical Industry".

Institute of Metals (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Prof. G. P. Thomson, F.R.S.: "Electron Diffraction" (thirty-third annual May Lecture).

Institute of Physics (London and Home Counties' Branch) (joint meeting with the Aristotelian Society and the Mini Association) (at the Royal Institution, 21 Albemarle Street, London W.1), at 6 p.m.—Conference on "The New Physics and Physical Materialism". Addresses by Prof. Susan Stebbing and Sir Jame Jeans, O.M., F.R.S.; discussion will be opened by Mr. R. B. Braithwaite and Prof. E. T. Whittaker, F.R.S.

Thursday, May 20

Institute of Fuel (at the Institution of Mechanical Engineers Storey's Gate, London, S.W.1), at 5.30 p.m.—Mr. O. W. Roskill "Statistics in the Fuel and Power Industries".

Friday, May 21

Institution of Electrical Engineers (Measurements Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. E. H. Rayner: "Measurement of Small Quantities".

Royal Institution (21 Albemarle Street, London, W.1), at 5 p.m.—Dr. H. J. Plenderleith: "The Preservation of Museum Objects i War-time".

University of Durham Philosophical Society and King' College Pure Science Society (at King's College, Newcastle-upon Tyne), at 5.15 p.m.—Prof. Max Born, F.R.S.: "Experiment an Theory in Physics".*

Saturday, May 22

Nutrition Society (at the London School of Hygiene and Tropica Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conferenc on "Nutrition in Infancy" (Chairman: Prof. L. G. Parsons).

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. G. Coumoulos: "Th Greek Scientists—Traditions and Ties".

APPOINTMENTS VACANT

Applications are invited for the following appointments on before the dates mentioned:

Senior Lecturer in Civil Engineering—Principal and Clerk the Governing Body, Wigan and District Mining and Technical Colleg Wigan (May 22).

Lecturer in Mechanical Engineering for the Schools of Technology, Art and Commerce, Oxford—Chief Education Officer, Cit Education Office, 77 George Street, Oxford (May 22).

Turbine Superintendent and Maintenance Engineer at t Generating Station of the County Borough of Brighton Electricit Undertaking—The Engineer and Manager, Brighton Electricity Unde taking, Electric House, Castle Square, Brighton 1 (endorsed 'Turbi Superintendent') (May 29).

Borough Electrical Engineer and Manager—The Town Cler Town Hall, Leyton, London, E.10 (May 31).

Teacher in Mathematics and Mechanics in the Technical Scho Norwich City College and Art School—Director of Education, Cit Hall, Norwich (June 5).

City Bacteriologist—The Town Clerk, Municipal Buildings, Da Street, Liverpool 2 (June 30).

Teacher of Mechanical Engineering or Mathematics an Physics—The Principal, Stroud and District Technical Colleg Kendrick Hall, Stroud, Glos.

Chief Engineer, with experience of high-power high-speed pet and Diesel machinery, in a shipbuilding and marine engineering firm Ministry of Labour and National Service, Appointments Office, Westwood Road, Southampton.

Lecturer in Biology—The Principal, St. Katharine's Colleg (Liverpool), at the Queen's Hotel, Keswick.

University College
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FUTURE OF THE CONTINUATION SCHOOL

ONE of the subjects that is exercising the minds of members of the Board of Education at the present time are the details of a system of continued education on lines calculated to meet the needs of individual adolescents and to make them more useful members of the community. So long ago as 1562 a national system of training for young people in all trades was introduced in Great Britain with the passing of "The Statute of Artificers". This made apprenticeship compulsory under the guild system, and although the law made no provision for the enforcement of this Act, the position of the guilds and, consequently, the care of young workers were considerably improved. It was a black period in British history for young people when the concentration of industry led to the repeal of "The Statute of Artificers" in 1814. To-day, for the second time within twenty-five years, a world war has brought about a quickened interest in part-time education for the adolescent, and now educationists are eagerly awaiting an overdue Education Bill with the Board's proposals for dealing with the problem.

The Fisher Act of 1918 empowered local education authorities to set up part-time day continuation schools for youth in industry, with an age limit of 14–16, to be raised to 18 at the end of seven years. One education authority alone, Warwickshire, has found it possible to adopt this recommendation and to-day we have but one statutory day continuation school in Great Britain (Rugby). In addition, there are twenty-six voluntary day continuation schools which are run under the ægis of local education authorities, and four schools which are conducted solely by the employers and are quite independent of the local education authorities. The combined experiences of these schools, which developed through the imagination and initiative of a number of far-sighted men and women, will need to be carefully weighed before plans for the future are formulated and laid down.

The British Association for Commercial and Industrial Education is an organization which speaks with considerable authority on the role of education in industry. It was a timely choice that prompted its members to take as their subject at a recent conference the place of part-time day education for new entrants to industry. The report* of its conference has now been issued and contains a useful summary of the experiences already gained in this field of work and offers many valuable suggestions that deserve close study.

Since the time when the Fisher Act made provision for a system of continued education, the supporters of these schools have been, as previously indicated, a very small minority. In 1938 only 40,000 out of two million children attended any classes during their working hours. Even to-day, employers who have seen in the day continuation school a means of easing the tremendous break between school and work for the young boy and girl, are still referred to by many educationists as "enlightened" and "progressive", although the epithets bestowed upon them by some of their fellow-employers suggest that they have lost their commercial or industrial acumen and that they are dabbling with experiments which have no relation to the successful running of their businesses. This point of view met with little support from Mr. Churchill in his broadcast speech of March 21, 1943, when he declared that "after school-time ends we must not throw our youth uncared for and unsupervised on to the labour market, with its 'blind alley' occupations which start so fair and often end so foul. We must make plans for part-time release from industry, so that our young people may have the chance to carry on their general education and also to obtain a specialized education which will fit them better for their work".

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* Part-time Day Education for the Adolescent. A Report of a Conference held on September 29, 1942, by the British Association for Commercial and Industrial Education. 1*s*.

What, then, are the advantages of these schools which are soon to be adopted as an integral part of the national educational system ? It will be apparent that any attempt to separate advantages that will accrue to the employer from those of benefit to the employee is almost impossible. A worker who is able to focus his full mental powers upon his particular job will inevitably be more acceptable to his employer than an employee who is uninterested and perhaps antagonistic towards his employment. Similarly, the employee who is mentally alert will enrich his experiences not only at his work-place but also in his leisure hours.

There are other advantages which are not quite so obvious. Where the school is closely linked with the firm, for example, and where the school staff know and are known by the firm's staff, the employer is able to get an independent opinion upon ability, character and general health from a staff who consider people for what they are rather than for what they can do in any one department. It is important that this opinion should come from the only department which regularly sees all the junior employees of the firm ; a foreman can give an opinion only upon those few with whom he comes in contact. In cases of promotion, change of occupation, removing square pegs from round holes, etc., the school report would be most useful and able to effect changes which would render dismissal impotent.

Benefits which show themselves in an absence of trouble are difficult to assess, because of their negative character, but these can still be seen on the physical side. In a well-run day continuation school, the students would be kept under constant medical supervision. Physical education would form a regular feature of the weekly activities, while games and other outdoor recreational pursuits would naturally be encouraged. During the years of bodily development these activities would almost invariably result in good physiological tone, which in itself is a safeguard against excessive accidents in the works as well as an effective check to absenteeism through sickness and ill-health.

Besides these direct advantages to the individual and his or her employer, there are those which arise from a person's duties and responsibilities in the social framework of national life. A good workman is not necessarily a good citizen ; but a good citizen is more likely to be a good workman than a bad citizen. This is highly significant when one remembers that the professional and skilled classes in industry are a very small and still decreasing proportion. As mechanization proceeds still further, semi-skilled workers will need greater and greater provisions for their training, if we are not to produce a type of individual whose personality and character become but a pale shadow of his repetitive work.

The form that part-time day continuation schools, or, as they are more likely to be called, colleges, will probably take can best be discussed by examining the already existing ones. These are of three types : those run by the local education authority ; those run conjointly by the local education authority and a works ; and the purely works school. While the latter may be possible for the bigger firms, it is to the local education authorities that we must look for the encouragement of institutions that will meet the demands of the smaller and diverse types of industrial organizations. The day continuation college controlled by the local education authorities wil possess at least one considerable advantage over that administered by a works. It will attract people drawn from various sides of industry ; the clerical worker and the technician should more easily develop mutual understanding in their common education.

A vexed question, on which the Board's pronouncement is awaited with keen interest, is the amount o time that is to be given to education each week Under the Fisher Act, youths were to be released from industry to continue their education for a period of eight hours weekly in a year of forty weeks. This is the practice at Rugby and other existing day continuation schools, particularly those in London. In Strode, Somerset, however, a day continuation schoo for shoemaker employees has been conducted on a half-time basis since 1926 and, according to one of th directors, Mr. J. A. Clark, possesses many advantage over the two half-days per week system. The latter system was tried at Strode but caused considerable annoyance and friction in the factory because of th difficulty of organizing a department to release boy and girls for odd periods. Under the present Strode system each vacancy in the factory is filled by tw boys or girls. When one works the other goes t school, and vice versa. This school has now been in action for fifteen years and the directors are unanimous as to its efficacy and value.

Other observers at this conference, however, wer strongly opposed to half-time schools, mainly becaus of the difficulties of organization and administratio that would be involved as well as the fact that th employment of a duplicate number of juniors woul involve a lessening of opportunities for promotio at the age of eighteen or twenty, with the inevitabl consequence of establishing a certain amount 'blind alley' employment. At the present time, too facilities for half-time continued education mus necessarily be restricted by the limited amount adequate and suitable accommodation. This is problem which could be solved within a decad however, and should not be presented as a too formidable argument against the half-time system.

Another and very real difficulty that will arise from the introduction of part-time education is the inconvenience caused to small firms by the release of boys and girls from their employment for a certain period each week. The same type of difficulty arises in a single department of a large firm, but it has already been seen in practice that by careful organization, continued good-will and constant consultation between the employer and the school, this problem is not incapable of solution.

The content of the school curriculum will also demand close scrutiny. Here, fortunately, the sponsors of the continued education movement speak with one voice as to the general policy, and, presumably, their experiences will guide the Board in its considerations. The education of new entrants to industry, according to Dr. F. H. Spencer and other speakers at this conference, should comprise : (*a*) a technical element, including craftsmanship and its scientific foundations ; (*b*) the consolidation of the general education of the students, their literacy, their knowledge of the humanities and of science ; and (*c*) some efforts to explain to young people the religion of their time and civilization. Above all, boys and girls should be given the opportunity of attaining complete self-fulfilment and the happiness that accompanies it, by finding the work that they are best fitted to do.

Obviously, the establishment of day continuation colleges will necessitate a considerable increase in the number of teachers in Great Britain. A cautious statement from the Board suggests that to meet all the demands that will be made upon them after the War, some 70,000 new teachers will be required. The National Union of Teachers puts the figure nearer 120,000. Under pre-war methods of training some 25,000 new teachers became available annually. Other sources of recruitment will thus have to be explored. Industry itself will probably supply the needs of adolescents in industry more effectively than the strictly academic products of the training college and the university training department. The latter might well spend part of their training in a factory if they intend to make teaching in a day continuation college their life's work. This would be an invaluable experience for those suited to the job, while those not suited would probably be deterred in good time. Moreover, intending teachers in these colleges should be keenly interested in the service of youth and prepared to devote much of their leisure time to extra-curricular activities. The day continuation college would then become the centre of the young person's educational and social life and would go far towards solving the difficulties experienced by the organizers of the so-called Youth Movement to-day.

There can be little doubt that the introduction of day continuation colleges will do much to secure the *rapprochement* between industry and education which is essential if Great Britain is to retain its position as a leading industrial and commercial power. An announcement as to their scope and organization within the national scheme of education will be greeted with keen interest.

BIRINGUCCIO IN ENGLISH

The Pirotechnia of Vannoccio Biringuccio

Translated from the Italian, with an Introduction and Notes, by Cyril Stanley Smith and Martha Teach Gnudi. (Publication sponsored by the Seeley W. Mudd Memorial Fund.) Pp. xxvi+476. (New York: American Institute of Mining and Metallurgical Engineers, 1942.) 5 dollars.

IT is generally acknowledged that the standard medieval work on mining and metallurgy is Agricola's "De Re Metallica", first published in 1556, at Basle. This handsome folio volume, beautifully printed and produced by the famous house of Froben, with a wealth of artistic and informative woodcuts, forms a noble ornament to any library, quite apart from its scientific value. In his preface to the work, dated 1550, Agricola wrote : "Recently Vannucci Biringuccio, of Sienna, a wise man experienced in many matters, wrote in vernacular Italian on the subject of the melting, separating, and alloying of metals . . . by reading his directions, I have refreshed my memory of those things which I myself saw in Italy". This is a reference to "De La Pirotechnia", written by Vannoccio Biringuccio and first published in 1540, at Venice. In reality, Agricola's indebtedness to the earlier work was very considerable, seeing that he drew from it the gist of his descriptions of the distillation of mercury and sulphur, the manufacture of glass and steel, and the crystallization of saltpetre, alum, salt, etc.

Of the surprising number of printed works issued before 1500, few dealt with science and none with metallurgy. Biringuccio's classic was the first work on practical metallurgy to be printed. Although the "Pirotechnia" appeared in six Italian and three French editions within 138 years, and was used and valued by practical men of the calibre of Robert Hooke, yet in the field of metallurgical literature it has always been overshadowed by Agricola's famous work : this result may be ascribed largely to the squat and unattractive format, the inferior illustrations and literary style, and the vernacular language of the "Pirotechnia". It is significant that "De Re Metallica" was published in a German edition in 1557, whereas no German version of the "Pirotechnia" appeared until 1925.

For the advent of an English edition, "De Re Metallica" had to wait 356 years, and the "Pirotechnia" 402 years. The volume now under notice, based on the original publication of 1540, is the first complete version in the English language of Biringuccio's masterpiece, although two fragments of it were 'Englished' in the sixteenth century. Richard Eden, indeed, finished an English translation of the first twenty-two chapters in 1552, but at that juncture was unfortunately persuaded to lend his manuscript to a friend who failed to return it. Somewhat later, as Dr. Smith points out, most of Book X was reproduced without any acknowledgment, together with copies of some of Biringuccio's illustrations, in Peter Whitehorn's celebrated military work of 1560, entitled "Certain waies for the orderyng of souldiers in battelray . . . and more ouer, howe to make saltpeter, gunpoulder and diuers sortes of fireworkes or wilde fyre . . ."

Fate has certainly dealt unkindly with the "Pirotechnia", and the book's undoubted influence on later metallurgical publications was mainly indirect. Even now there is no definitive edition of the Italian text; for although Aldo Mieli published the first volume of a critical edition in 1914, with valuable annotations and an introductory account of Biringuccio and his background, the work ceased at that point. Since 1925 the annotated German translation of Otto Johannsen has been the most useful version available; this was well produced and carefully edited. Now, at long last, justice has been done in the English tongue to this venerable pioneering work in the domain of metallurgy and related branches of science.

Vannoccio Biringuccio, the son of an architect of Siena, was born there in 1480. Like Benvenuto Cellini, twenty years later, he was probably trained locally as a craftsman, in an age which drew no essential distinction between the industrial arts and the fine arts. The knowledge which he records in the "Pirotechnia" was gained largely in his younger days, in the course of extensive travels in Italy and Germany. His chequered career was bound up with the fluctuating fortunes of the Sienese family of Petrucci: in 1516, and again in 1526, he was declared a rebel and exiled from Siena. Later, however, matters were composed, and in 1531 Biringuccio became a senator of his native city. In the years that followed he was appointed architect and director of the Opera del Duomo, besides being called upon to cast arms and build fortresses at Venice and elsewhere in Italy. As regards the "Pirotechnia", internal evidence indicates that it was written after 1534. Eventually, in 1538, Biringuccio took charge of the papal foundry and munitions in Rome. Soon afterwards he died, either in 1538 or early in 1539.

The "Pirotechnia", no less than his other activities, shows that Biringuccio's outlook was emphatically practical. He was strongly individualistic and relied upon his own observation, experience and common-sense. Like his contemporary, Paracelsus, he had little respect for the orthodoxy of a hoary and enslaved literature, or for "the authority of hearsay in place of reasons for possible success or facts that can be demonstrated", as he phrased it; "I have no knowledge other than that gained through my own eyes," he wrote. Thus the "Pirotechnia" is a source book, full of first-hand descriptive accounts of arts and processes depending upon a practical knowledge of ores, metals and salts. "It was men like Biringuccio," says Dr. Smith in his introduction, "the practical metalworkers, dyers, pottery makers, alum boilers, and kindred artisans, who accumulated the basic facts for a chemical science during the period in which learned men of church and university were engaged in lengthy but barren theological disputation. The artisans were the true scientists of this period."

Biringuccio had no sympathy with the hazy doctrines of the alchemists, although he was ready to give credit to the 'puffers' for an occasional useful discovery made in the laboratory. He pokes gentle fun at the loudly proclaimed virtues of potable gold and the philosopher's stone: "their fantastic writings are but masked shadows", he writes of alchemical lucubrations; "the best thing to do is to turn to the natural gold and silver . . . rather than that of alchemy, which . . . has never been seen by anyone". In bidding adieu to the alchemists he exclaims characteristically that when considering them his thoughts "press forward in a throng like dogs happy in the chase, each one desirous of coming out first".

The "Pirotechnia" opens with an account of ores of the common metals, followed by a description of the making of steel and brass. The so-called semi-minerals are next discussed: these include quicksilver, sulphur, antimony, arsenic, common salt, borax, rock-crystal, gems, glass, many ores, and salts in general. The numerous operations then described in detail include the assaying and smelting of ores; the separation of gold from silver; alloying; casting; the melting of metals; the arts of the goldsmith, coppersmith, pewterer, potter, etc.; the manufacture of saltpetre, gunpowder and fireworks to be used in warfare and for festivals. There are eighty-four illustrations, the great variety of which may be gauged from such titles as the following: miners' tools; an assaying laboratory, showing balances, muffle furnace for cupelling, etc.; the bell foundry; furnace for welding cracked bells; wind furnaces; treadle-operated bellows; machine for boring guns; cucurbits, alembics, and receivers; distillation of alcohol; bell for collecting oil from burning sulphur; wire drawing; goldbeaters at work; the pottery; brick and lime-kilns; loading and aiming a gun; fire-pots with slings, and incendiary arrows and girandoles.

Of all the editions of the "Pirotechnia" this one does most justice to the original work. The translation has been accomplished with great care, and the introduction, annotations, appendixes and bibliography leave little to be desired. The book is a sumptuous and beautiful production, with a large page, clear type, sharp illustrations, and wide margins. Mistakes there are, to be sure (such as "Charles Pack" for "Christopher Packe", "J. H. Hopkins" for "A. J. Hopkins", and "Reed" for "Read"); but these are not numerous. It is not too much to say that this edition will take rank as the standard rendering of the "Pirotechnia" for the English-speaking world, and that Smith and Gnudi have done for Biringuccio in 1942 what the Hoovers achieved with such distinction for Agricola in 1912.

JOHN READ.

THE MAKING OF AN ENGINEER

The Making of an Engineer

Pp. 82. (Hebburn-on-Tyne: A. Reyrolle and Co., Ltd., n.d.) n.p.

SEVERAL groups of people operating under a variety of auspices have produced reports during recent months dealing with the education and training of young people prior to, and during, their employment in industry. In the main, these reports have dealt with the principles which must be adhered to in the intended reorganization of the pre-war system obtaining in Great Britain, but the precise manner in which the various recommendations will be put to practical effect remains in general to be formulated. This recent publication of Messrs. Reyrolle differs in that it gives a practical example; an example which illustrates the manner in which an industrial concern, which recognizes and accepts responsibility for ensuring the continued education and effective practical training of its recruits, can contribute to the national well-being—while at the same time, of course, ensuring its individual prosperity.

Fortunately this firm is not the only one in Great Britain which has made such a contribution, and there is good evidence to show that many others are making preparations to this end. For some years past most of the large electrical engineering concerns, in particular, have organized schemes of practical training embracing their several grades of recruit—from the elementary school boy to the university graduate—along lines similar to those described, though in few cases have the arrangements been so comprehensive.

The Reyrolle firm has evidently taken particular care in providing for the up-grading of its more promising trade apprentices. Part-time day release to attend courses of technical instruction at the local colleges is granted to all who are able to derive full benefit from them, and the broadmindedness of the firm may be judged further from the statement that it affords "particularly favourable opportunities" to those so inclined "of securing appointments elsewhere, at home or abroad, after their training". This willingness to regard themselves as training grounds for the industry as a whole is characteristic of the large electrical engineering concerns of Great Britain. It is an excellent augury for the future prosperity of this industry and an inspiring example to others not yet so enlightened.

The information provided in the publication does not permit a critical analysis of the actual training arrangements, but it seems that the whole of the practical experience is gained in the main workshops. In the opinion of an increasing number of people, special apprentice workshops, separated from the productive activity, should be provided for the purpose of ensuring a broad preliminary acquaintance with all significant manual and machine operations. Little is said, either, about the procedure adopted in the selection of recruits to the various forms of apprenticeship; the importance of this problem is being recognized increasingly, and one would like to know the extent to which use is made of psychological tests, in relation particularly to the trade apprentices.

The publication has been prepared in a most attractive manner; it is very fully illustrated with examples of engineering practice, and after reading it few will question the correctness of an early statement that "to anyone with the right aptitude engineering offers the possibilities of a rich and interesting life".

WILLIS JACKSON.

THEORY AND PRACTICE OF HEAT ENGINES

The Theory and Practice of Heat Engines
By D. A. Wrangham. Pp. xii+756. (Cambridge: At the University Press, 1942.) 50*s*. net.

IN many respects this is an outstanding book, well produced and exceptionally well illustrated, giving a clear account of the usual subject matter, together with chapters on heat flow, combustion, flow of fluids, and also on modern boiler plant, turbo-power plant, and the elements of economics of plant layout. The practical aspect is kept constantly to the fore, and plenty of numerical examples given at every stage. As a general criticism, however, the book, while falling short of a comprehensive treatise, is on the expensive side for students, especially since the treatment makes no particular claim to novelty.

To write a comprehensive account of the theory and practice of heat engines, including the theory treated as a branch of thermodynamics, and all the up-to-date practical developments, would be a big task, certainly running to more than one volume, and each of the practical sections, for example, internal combustion engines, would have to bear comparison with books devoted entirely to the one branch. A single volume must, therefore, always be open to criticisms of omission, and it becomes a question of what to put in and what to leave out. For degree students, however, Mr. Wrangham covers the field well, although for so large a volume the theoretical sections are rather sketchy.

Opinions among teachers may differ as to how far students of heat engines should be acquainted with the wider field of thermodynamics, but few would deny the importance of a sound introduction to fundamentals. On the whole the book is satisfactory in this respect, but there are some grounds for criticism. This raises the whole question of haziness in fundamentals in books on heat engines, and the following remarks apply no more to the present book than to many others. Some well-known writers, for example, continue quite incorrectly to represent irreversible processes, such as unresisted expansion, by a curve on a pressure-volume diagram, and speak of the area beneath the curve as 'work wasted', when in fact the work is non-existent. Heat and temperature are not clearly distinguished, the term 'adiabatic' is used in two different senses, sometimes as a quite unnecessary alternative to 'isentropic', and sometimes to denote any process where no heat is interchanged with the surroundings, thus including an irreversible process such as throttling. Again, the wide use of the term 'pressure energy' tends to mislead the beginner, who may picture a specific gas property akin to the potential energy of a coiled spring, when actually, for any given temperature, a perfect gas has the same energy whether it occupies a small volume at high pressure, or a large volume at low pressure. It is just this distinction which differentiates thermodynamics from mechanics. Too narrow an outlook is perhaps responsible for some of the confusion, and is scarcely likely to lead to the best teaching. Common agreement as to the meaning of terms would also help.

Mr. Wrangham introduces the kinetic theory of gases at the outset, and his brief treatment is sound except for one or two loose statements in which the statistical nature of this theory is not made clear. Thus, on p. 23, referring to diffusion, he says, "the molecules of one gas will invade those of the other and gradually they will all acquire a common velocity", whereas in the completely mixed state it is the mean kinetic energies of the two gases which are equalized. Again, on p. 25, it is stated that "the kinetic energy of all molecules at the same temperature is the same, whatever their mass". Such statements, arising from the author's use of an "average" molecule possessing the root mean square velocity, may mislead the student to think of an individual molecule as possessing temperature, and to obscure the important difference between the translational kinetic energy of a mass of gas, which is completely convertible into work, and the mean kinetic energy of random molecular motion, or heat, which is only completely convertible into work by a reversible expansion down to absolute zero temperature. In a volume of this size one might reasonably expect greater attention to these finer points.

Nevertheless, to the student who can afford the time and money, and who is already to some extent familiar with fundamentals, the book can be recommended and should prove very valuable.

O. A. SAUNDERS.

Switchgear Practice

By Arthur Arnold. Pp. iv+238+27 plates. (London: Chapman and Hall, Ltd., 1942.) 22*s.* net.

A BOOK on this subject, planned as this one is, has been needed for a long time, for while there is an extensive literature in the form of articles and papers presented before the professional engineering institutions, contributions in book form are relatively scanty. Those which have appeared have generally been written by and for switchgear designers, so that one having a particular appeal for the user-engineer fills a distinct gap which has existed in the technological book world.

The scope of the work is wide, ranging as it does from motor starters to high-rupturing capacity circuit-breakers. The treatment accorded to it is based upon a presentation of the main principles controlling the selection of suitable gear for the many purposes which arise in practice; design data and constructional details are omitted, as being outside the conception of the book. The first four chapters deal with D.C. breakers, motor starters, controllers and switchboards, the rest of the book describing A.C. breakers of small and medium sizes and those for heavy-duty service, A.C. busbars, arc control devices, interlocks, testing, switchgear protective devices, instrument and control boards, lightning arresters, fire prevention and protection, and oil-less circuit breakers.

There is a surprising omission of reference to the pioneer research and development done by the British Electrical and Allied Industries Research Association on gas-blast circuit-breaker development, and no record in the bibliography of the published work of Wedmore, Whitney and Bruce of that body. Such work may not be 'recent', but it is too fundamental to be ignored, and British engineers have led the way in this important phase of large power control. Methods of calculating network fault currents might also, with advantage, have been given in the book—it is a feature of prime importance to the user and one which he needs to predetermine when specifying the requirements of a circuit breaker. The book, however, constitutes a useful survey of modern switchgear practice and it should enjoy a ready acceptance by operating engineers.

Air Navigation

British Empire edition, by Lieut.-Comdr. P. V. H. Weems. Revised and edited by Arthur J. Hughes and P. F. Everitt. Second edition. Pp. xxi+519. (London: McGraw-Hill Publishing Co., Ltd.; New York: McGraw-Hill Book Co., Inc., 1942.) 35*s.*

AS a practical manual of air navigation, this book can be thoroughly recommended. It describes the methods of navigation by pilotage, dead reckoning, radio position finding and celestial observation, with a comprehensive account of the instruments employed and of the various tables for facilitating the determination of position. It contains little in the way of mathematics and does not go at all deeply into the theory of the methods. The outlook is essentially practical rather than theoretical. An unusual feature in a work of this sort, but one of undoubted value for the air navigator, is an excellent outline of meteorology by Dr. Sverre Peterssen. The book contains a large number of figures, diagrams and illustrations of various instruments and forms a useful work of reference.

There are a few statements which are inaccurate or misleading; but it is not correct, as stated on p. 75, that a magnetic compass points towards the north magnetic pole, nor is it true that the changes with time in the magnetic variation are due primarily to the movement of the earth's magnetic poles. The statement on p. 330 that "better navigation can now be done by using two good second-setting watches, checked daily, than is possible with two or three high-class chronometers when these are checked only occasionally", is not pertinent to the relative time-keeping properties of watches and chronometers. In these days when radio time signals are generally available, there is no reason why chronometers should be checked only occasionally. Though a good performance can be expected from a high-grade watch, this affords no justification for belittling the better performance of which a chronometer is capable. H. S. J.

Food, Health, Vitamins

By Prof. R. H. A. Plimmer and Violet G. Plimmer. Ninth edition. Pp. vii+193. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1942.) 7*s.* 6*d.*

Vitamins and Minerals for Everyone

By Alida Frances Pattee. Pp. xviii+242. (New York and London: Putnam and Co., Inc., 1942.) 10*s.* net.

"FOOD, HEALTH, VITAMINS" has reached its ninth edition and is so familiar as to need little further notice. It has made its way on merit and to-day is acknowledged to be an excellent introduction to the subject of nutrition. New material has been added which gives the results of various war-time nutritional experiments, and the numerous tables have been overhauled and brought up to date.

"Vitamins and Minerals for Everyone" is a queer mixture. It has been written and arranged "for both the profession and the laity", and has catered happily for neither. The laity is provided for by some dramatic interludes which remind one of the commentaries of a Wild West serial produced in Hollywood. The contribution "for the profession" includes an account of the part played by vitamins and trace elements in human nutrition together with a valuable appendix of relevant nutritional tables.

Biology Staining Schedules for First Year Students

By R. R. Fowell. Pp. 20. (Swansea: The Author, Swansea Technical College, 1943.) 1*s.* 6*d.*

THIS little laboratory manual presents in a clear and compact form the practical directions necessary to enable the student to master a limited number of staining techniques, which have been chosen as those most suitable for students or senior pupils working through courses for the Intermediate B.Sc. or B.Pharm., First Medical or Higher Certificate.

A preliminary section deals with such matters as the classes and uses of stains. Tables are given of the chief staining reagents and some advice on staining, which might have been advantageously extended. This is followed by five pages of botanical methods and seven pages of zoological methods, mostly variants of hæmatoxylin methods, but including smears and whole mounts.

Modest though the booklet is, it is well suited to the type of student for whom it is intended. Far too little work is done on permanent preparations by junior students, and this booklet should stimulate improvement in this respect. R. C. McLEAN.

COPERNICUS AND THE HELIOCENTRIC THEORY

By Dr. H. SPENCER JONES, F.R.S.
Astronomer Royal

On May 24, 1543, died Nicolaus Copernicus. A few days previously, as he lay on his death-bed, the first printed copy of his great work, "De Revolutionibus Orbium Cœlestium", which was destined to become the cornerstone of modern astronomy, was placed in his hands.

Copernicus was born in 1473 at Thorn, on the Vistula, a town which belonged to the Hansa League and which a few years before had come under the suzerainty of Poland. His father was a merchant, who in 1462 had come to Thorn from Cracow, where his grandfather had settled in 1396. His mother, Barbara Wasselrode, came of an old Polish family and was the sister of the Bishop of Ermland. Thus Copernicus was a Slav by ancestry and a Pole by birth. When he was ten years old, his father died and his uncle, the Bishop, took charge of his education. At the age of eighteen, he went to the University of Cracow to study medicine; there he seems first to have become attracted to philosophy, mathematics and astronomy. In 1496 he went to Italy and studied at Padua and Bologna.

At the University of Bologna he came under the influence of Dominico Maria da Novara, an ardent Neo-Platonist, who favoured the Pythagorean doctrines and criticized the Ptolemaic astronomy for its artificial complexity. Copernicus became familiar with the early Greek philosophical and astronomical speculations, which the recent invention of printing was making more readily available. It was probably as the result of Novara's influence that he formed the idea of attempting to construct a different and simpler system of astronomy, founded on the idea that the sun, and not the earth, is the centre of the universe.

In 1505 Copernicus returned to his native country, having been appointed a canon of the Cathedral of Frauenburg. He resided at the episcopal palace of Heilsberg as his uncle's physician until 1512. In that year his uncle died and Copernicus retired to Frauenburg, where the remainder of his life was spent. It was in the quiet years spent at Heilsberg that he put into shape his ideas about a new system of astronomy and prepared the first draft of a work setting forth his system and the arguments for it, and comparing it with observation. This draft was completed about 1514. Copernicus kept the manuscript by him, revising it from time to time and making further comparisons with observations. It would seem that the great work must have been nearly in its final form by about 1529, as no observations of a later date appear in the book. To about this date belongs the MS. "De Hypothesibus Motuum Cœlestium Commentariolus", a short account of his new system, with some of the evidence for it but with none of the calculations, which he prepared for circulation among his friends.

Probably through the circulation of the "Commentariolus", it gradually became widely known that Copernicus held the novel view that the sun and stars were at rest and that the earth revolved round the sun. Luther, in his "Table Talk", called Copernicus a fool for holding such opinions, which were contrary to the Scriptures; but Copernicus ignored these and similar attacks and took no steps to publish his work. The Catholic Church at this time did not raise any objections to the heliocentric system, probably because its implications had not been fully realized. In 1533 a lecture on the ideas of Copernicus was given by one of the Roman astronomers at the request of Pope Clement VII, and in 1536, Cardinal Schonberg wrote to Copernicus for some further information about his theories and urged him to publish his work, as did also his friend Gysius, Bishop of Kulm. At length in 1541 he yielded to the importunities of his friends and particularly of his enthusiastic disciple, Georg Joachim, generally known as Rheticus, who had already published a valuable account of the new system known as the "Narratio Prima", in the form of an open letter to his old master Schoner. Copernicus sent the manuscript of his work to Gysius, who entrusted it to Rheticus to arrange for its printing in Nuremberg. Rheticus, being unable to see it all through the press, obtained the assistance of Schoner and of another friend Osiander, a Lutheran preacher interested in astronomy.

To Osiander was due the insertion, without the knowledge of Copernicus, of an anonymous prefatory note entitled "Ad lectorum de hypothesibus huius operis", which refers to the sun being placed at the centre of the universe as a mere hypothesis, not necessarily true or even probable, made for the purpose of facilitating calculation. Osiander was no doubt unwilling to countenance the reality of the new theory and thought it prudent to disarm prejudice and to overcome religious scruples. But this anonymous prefatory note caused a widespread and mistaken belief in the sixteenth century that Copernicus had advanced his theory merely as a mathematical device and that he did not consider it physically true. Copernicus, however, had expressed his position clearly in his preface, addressed to Pope Paul III, where he explained the reasons which had eventually persuaded him to publish his work. He stated that he regarded a belief in the central position and immobility of the earth as absurd; he attacked without fear the stupidity of those who held such false opinions and scorned those who, without any knowledge of mathematics, distorted passages in the Holy Scriptures.

On the eve of publication of "De Revolutionibus" the system of cosmology most generally accepted, so far as physical theories were concerned, was that of Aristotle. The earth was at the centre of a system of material spheres, to which the planets were rigidly attached. The fixed stars were attached to an outer sphere, the *primum mobile*, which rotated in twenty-four hours; beyond this sphere nothing whatever existed. The planetary spheres rotated in the opposite direction to the sphere of fixed stars, but were dragged along by its superior force. Saturn, the planet nearest to the stellar sphere, required the longest time to complete its revolution, because it had the greatest difficulty in overcoming the force of the stellar sphere; the moon, on the other hand, being nearest to the centre, had the least difficulty and therefore took the least time to complete its revolution. The solid earth was in the centre because the heaviest elements seek the centre; the watery sphere encompassed the earth; the sphere of air came next; and above it, but below the moon, came the fiery sphere, because fire tends to rise above air. The region above the moon was eternal and unchanging; transitory celestial phenomena, such as meteors and comets, appeared either in the air or in the fiery sphere. Each simple body had one, and only one, simple motion natural to it. There were two simple types of motion, rectilinear and circular. The four elements, earth, air, fire and water, were simple bodies and had rectilinear motion, either downwards, as in the case of earth and water, or upwards, as in the case of air and fire. The sublunar regions must therefore be subject to constant change or decay, because these were the products of the conflict of contraries. The heavenly bodies were composed of a fifth simple body, the natural motion of which was circular; as this type of motion had no contrary, the fifth simple body was eternal and not subject to change. If a body had any other movement, it must be caused by an external force; but because a force could not be perpetually applied, a second movement could not be perpetual. The system of homocentric spheres was entirely inadequate to represent the motions of the heavenly bodies; so a complicated system of epicycles and eccentric circles had been merged with it. The Ptolemaic system was accepted as providing the best agreement with observation. But whereas Ptolemy had regarded his system primarily as a mathematical representation, his successors had sought to give physical reality to his deferent and epicyclic circles; they were pictured as the equators of solid crystalline spheres, moving within the annular space between two solid spheres.

What Copernicus achieved was the construction of a complete new system of astronomy, the first since the days of the Alexandrian school. It is against the background of the Aristotelian cosmology that this achievement must be appraised. It is true that Copernicus had precursors among the ancients, as he mentions, who had taught that the earth was in motion. But none of these had done more than to throw out their ideas as mere philosophical speculations. They had not followed them to a logical conclusion, nor developed them into a complete system, which could be made subject to calculation and shown to be capable of explaining the complicated motions of the planets. It is to Copernicus, and to Copernicus alone, that the credit for the heliocentric system is due.

The fundamental idea at the basis of this system is simplicity of explanation of the celestial phenomena. The appearance of the movements of the celestial bodies is the same if the earth turns from west to east as if the heavens turn from east to west. The earth appears to be the centre of the movement; but it is not reason which must decide, it is the simplicity of causes, and it is simpler to suppose one globe to move than hundreds of thousands. Because heavy bodies tended towards the centre of the earth, it was thought that this must be the centre of the universe. But there was no longer any reason to prefer the earth as the centre if all other bodies had gravitation. Copernicus believed that gravitation was a universal force. He said:

> "I, at least, am of the opinion that gravity is nothing else than a natural force planted by the divine providence of the Master of the World into its parts, by means of which they, assuming a spherical shape, form a unity and a whole. And it is to be assumed that the impulse is also inherent in the Sun and the Moon and the other planets, and that by the operation of this force they remain in the spherical shape in which they appear."

It is difficult to avoid judging the ideas of former ages by our own, instead of viewing them in comparison with those that went before them. In the time of Copernicus, the physical objections to the earth's rotation were serious. It was believed that if the earth rotated it would fly apart, that objects dropped from a height would fall far to the west, that anything not fixed to the earth would be torn from it and that clouds would always move towards the west. It was not until Galileo conceived the principles of elementary mechanics that such objections could be properly refuted. Copernicus possibly suspected that all was not well with the current ideas about mechanics; he countered the objections to the hypothesis of the rotation of the earth with the retort, "What holds together the rotating heavens in the Ptolemaic theory?"

With regard to the revolution of the earth about the sun, Copernicus argued as follows:

> "If then the Earth possesses other motions besides that around its centre, then they must be of such a character as to become apparent in many ways and in appropriate manners; and amongst such possible effects we recognise the yearly revolution. If one admits the motionlessness of the Sun, and transfers the annual revolution from the Sun to the Earth, there would result, in the same manner as actually observed, the rising and setting of the constellations and the fixed stars, by means of which they become morning and evening stars; and it will thus become apparent that also the stations and the retrogradations of the planets are not motions of these but of the Earth, which lends them the appearance of being actual planetary motions. Finally, one will be convinced that the Sun itself occupies the centre of the universe."

The Copernican system not only provided a simple explanation of the stationary points and retrograde motions of the planets but also, and for the first time, enabled the dimensions of the orbits of the planets to be determined in terms of the distance of the earth from the sun. The relative distances found by Copernicus were nearly correct. This was a great advance; the epicyclic system could give no information whatever about the actual distances of the planets but merely, for each planet, the ratio of the radii of the deferent and epicycle. The Arabian astronomers had assumed that the greatest distance of any planet was equal to the least distance of the one next above it and that the sphere of the fixed stars was at a distance equal to the greatest distance of Saturn. But inasmuch as Copernicus accepted the erroneous value of 3′ for the solar parallax, found by Hipparchus, the dimensions, in miles, of the solar system that he obtained were only about one twentieth of the true values.

To Copernicus, as to his contemporaries and also to the Greeks, the simplest form of revolution of one body about another was a motion as if the two bodies were rigidly connected. In order that the earth's axis should have a fixed direction in space, he therefore had to assume a motion of the axis around a cone, in a period of a year. But in order to account for the precession of the equinoxes, which he determined as 50·2″ annually—a value that is very close to the true value—he supposed that the motion was completed in slightly less than a year. The net effect was to give the earth's axis a slow conical motion in space, with a period of 26,000 years. Precession had been recognized by Hipparchus as a motion of the celestial equator, such that its inclination to the ecliptic remained unchanged but so long as the earth was supposed to be at rest at the centre of the universe, it was not possible to relate precession in any way to the earth's axis.

Copernicus took over from the Arabian astronomers the imaginary phenomenon of trepidation—a supposed oscillation of the equinoxes backwards and forwards, which caused the value of the precession to fluctuate; associated with it was a spurious variation in the obliquity of the ecliptic. To account for trepidation, Copernicus assigned two librations to the earth's axis. Thus, in his system, the earth had movements of rotation and of revolution, together with a combined progressive and wobbling motion of its axis. To those imbued with the Aristotelian conception that the heavenly bodies could have only circular motion, the gratuitous introduction of three motions was a serious objection to the Copernican system.

By placing the sun at the centre and assuming the diurnal rotation and annual revolution of the earth, Copernicus had brought about a great change in outlook, but when he came to the detailed representation of the motions of the bodies in the solar system, he had to revert to the Ptolemaic system of eccentric and epicyclic circles. Chapter IV of Book I of "De Revolutionibus" is entitled: "That the motions of the Heavenly Bodies are Uniform, Circular, Uninterrupted or are made up of Combined Circular Motions". The number of circles was reduced from about eighty to thirty-four, so a considerable simplification in detail, though not in method, was brought about. But no other course was open to Copernicus. The accurate observations of Tycho Brahe (1546–1601), from which by laborious calculations Kepler (1571–1630) was to prove that the orbits of the planets are ellipses, were yet to be made. Copernicus did succeed in improving appreciably the elements of the planetary orbits. The tables constructed by Erasmus Reinhold on the basis of the calculations of Copernicus, published in 1551 and known as the "Prutenic Tables", were decidedly superior to their predecessors, the "Alphonsine Tables" (published in 1272), and were used for calculating the places of the celestial bodies until superseded by the "Rudolphine Tables" of Kepler (published in 1627). The Prutenic Tables, though they provided no sort of justification for the Copernican system, undoubtedly did much to induce astronomers to recognize its merits.

In the Ptolemaic system, the sphere of fixed stars was located just beyond the sphere of Saturn. But in the Copernican system a vast space was left between Saturn and the stars. Copernicus recognized that if the stars were near they would show an appreciable annual parallax, resulting from the motion of the earth round the sun. As no parallax had been detected, the stars must be at a great distance. The instruments of the time might have ust detected a parallax of 5′, which would require he stars to be at least seven hundred times as far from the earth as the sun is. This enlargement of the universe was, of course, a change of degree rather than of kind. The objections to it in the ime of Copernicus were scientific rather than philosophical. At that time, the angular diameters of the stars were very much over-estimated. Tycho Brahe assumed smaller apparent diameters than did any other astronomers before the invention of the telecope. He assigned a diameter of 2′ to a first magnitude star. But in the time of Copernicus a diameter of 5′ would have been considered reasonable. Such an angular diameter would require the actual diameter of the star to be not less than the distance of the earth from the sun. The opponents of the Copernican system could contend with some reason that it was less credible that the stars could be of such vast dimensions than that the sphere of stars was in rotation, and that Copernicus had made an entirely unjustifiable assumption that the stars were at a very great distance merely to obviate the serious difficulty that the stars showed no annual parallax. This was one of the main reasons that caused Tycho Brahe to reject the Copernican system and to substitute in its place a geocentric system, in which the sun revolved round the earth but all the other planets revolved round the sun; mathematically, the Tychonic system was identical with the Copernican system.

Though in "De Revolutionibus" Copernicus represented the stars as being on a sphere and all at the same distance from the earth, he recognized that the stars, being assumed at rest, might well be scattered throughout an infinite universe. But this could not be tested in his day by observation, and he declined to commit himself on the question. In Book I, Chapter VIII, he says:

> "For the chief reason that has moved some to think the Heavens limited was motion, which they thought without controversy to be indeed in it. But whether the world have his bounds or be indeed infinite and without bounds, let us leave that to be discussed of philosophers."

It was Thomas Digges (1546–1595), the English mathematician and astronomer, who first broke definitely with the older cosmologies which had assumed the stars all to be at the same distance. In his "Perfit Description of the Caelestiall Orbes", first published in 1576, an English translation was given of the principal chapters of Book I of "De Revolutionibus", with some paragraphs explaining his own ideas, of which the following is an extract:

> "We may easily consider what litle portion of gods frame, our Elementare corruptible worlde is, but neuer sufficiently be able to admire the immensity of the Rest. Especially of that fixed Orbe garnished with lightes innumerable and reachinge vp in *Sphaericall altitude* without ende. Of whiche lightes Celestiall it is to bee thoughte that we onely behoulde sutch as are in the inferioure partes of the same Orbe, and as they are hygher, so seeme they of lesse and lesser quantity, euen tyll our sighte beinge not able farder to reache or conceyue, the greatest part rest by reason of their wonderfull distance inuisible to us."

The reputation of Thomas Digges as a man of science, his advocacy of the Copernican system, the popularity of the "Perfit Description", which went through many editions, whereby an account of the Copernican system was made available to those who could not read Latin, did much to bring about its earlier acceptance in England than on the Continent.

Though Tycho Brahe, as we have seen, did not accept the Copernican system, yet the observations of this most assiduous and systematic observer of the heavens before the days of the telescope did much to help it forward. In 1572 a bright new star appeared, of which he obtained a long series of observations. His discussion of these established that the star was not a comet, as many had thought, and that it was more distant than Saturn. His observations of the great comet of 1577 proved that it was far more distant than the moon and therefore not in the sphere of fire where, according to Aristotle, comets were situated. Thus the region beyond the moon was not, as Aristotle had supposed, eternal and unchanging. By giving so severe a blow to the Aristotelian theories, Tycho Brahe helped to remove one of the chief obstacles to the progress of the Copernican theories.

The first attempt at a physical explanation of the rotation of the earth was due to William Gilbert who, in his "De Magnete", published in 1600, ascribed it to the magnetic properties of the earth. Gilbert found that his terella or magnetized sphere rotated under the influence of a magnetic field. Though Gilbert's theory was not correct, by providing a plausible explanation of the rotation, it removed an objection to the Copernican system and it was accepted by Kepler and Galileo as a tentative hypothesis.

In 1609 Kepler published his book "De Motibus stellæ Martis", announcing his discovery and proof of the elliptical orbit of Mars, which was destined to cause the final disappearance of eccentric and epicyclic circles. This remarkable discovery would not have been possible if Kepler had not accepted the heliocentric theory. In the same year Galileo constructed his first telescope. In 1610 his discovery of the satellites of Jupiter was announced in the "Sidereus Nuncius"; in 1611 he discovered sunspots, which he announced in 1612 in the "Discorso" and more fully in 1613 in the "Istoria e dimostrazioni"; he also observed the phases of Venus and Mercury. These observations of Galileo made it seem probable by analogy that the earth rotated on its axis and that, with the other planets, it revolved about the sun.

When the attack on Galileo was made by the Catholic Church, the "De Revolutionibus" was placed on the papal "Index" in 1616 and declared heretical. The book was only allowed to be read provided all passages referring to the motion of the earth were altered to assert that this idea, though false, was introduced merely as a mathematical hypothesis to simplify the calculations. The Tychonic system, unlike the old Ptolemaic system, could be reconciled with these new discoveries, and it therefore remained as the only serious competitor to the Copernican system, though it was generally modified to admit of the rotation of the earth. Nevertheless, by the end of the seventeenth century, the Copernican system had finally displaced the Tychonic system. This was not because direct observation had provided any confirmation of the Copernican system, but because the heliocentric system was better adapted to the physical and mechanical explanation of the planetary motions. It fitted in naturally with Newton's mathematical demonstration of Kepler's laws of planetary motion in terms of universal gravitation. Observational proof of the revolution of the earth round the sun was eventually provided by Bradley's discovery of aberration, announced in the *Philosophical Transactions* in 1729; the first definite detections of the parallax of a fixed star came long afterwards and were announced almost simultaneously by Bessel in 1838, by Henderson in 1839 and by Struve in 1840. But the Copernican system had become firmly established and universally accepted long before these observations had proved its truth. With its acceptance, the conception of a small geocentric universe had finally to be abandoned, and a profound revolution in human thought and outlook had been accomplished.

THE WORK OF COPERNICUS

At the meeting of the Royal Astronomical Society, held at Burlington House on May 14, Prof. Herbert Dingle gave an address on Copernicus, which supplements in some respects the article by Dr. Spencer Jones printed above. It is not generally known that Copernicus attained some proficiency in languages and even published a translation from Greek into Latin of the poems of Theophylactus Simocatta. He possessed some artistic skill, and the famous clock tower of the cathedral at Strasbourg contains a copy by other hands of his self-portrait.

In spite of his attainments, more especially in the realm of astronomy, Copernicus had a natural humility which led him to shun publicity both for himself and his work, and he was even prepared to depreciate his own worth in comparison with that of others. His dread of derision, not the fear of persecution, was largely responsible for the delay in the publication of his great work, "De Revolutionibus Orbium Coelestium". There is no evidence that he concealed his thoughts because he dreaded persecution—a popular belief which probably emanated from the fact that his work was not published until the end of his life. Many years before this, his views were well known wherever astronomy was studied because he had circulated (in manuscript form) a summary account of his astronomical system. Although this was limited to those capable of judging, his reputation was established, and ten years before his death the papal secretary delivered a lecture on his system to the Pope and his Court. No question of persecution arose as a result of promulgating his views, and he was obviously held in high esteem even in middle life, because so early as 1514 he received an invitation from the Lateran Council in Rome to assist in the reformation fo the calendar. His grounds for refusal are interesting; he held that such a reformation could not be carried out adequately owing to the incomplete knowledge of the motions of the sun and moon.

It must not be assumed that because there was no fear of persecution Copernicus was not subjected to ridicule. Luther poured contempt on his system and even predicted that he would overturn the whole science of astronomy—a prediction which was literally fulfilled, but not in the sense intended by Luther. Twelve years before his death he had been satirized on the stage at a place near Frauenberg, and this and various misunderstandings of his views were very painful to his sensitive nature. In the dedicatory letter to the Pope, prefaced to "De Revolutionibus", he admits that misunderstanding had been responsible for preventing him from publishing his views previously.

It is sometimes assumed that Copernicus' work is of a very controversial nature, but it is not primarily polemical; it is a complete treatise on astronomy in which the centre of the earth is discarded in favour of the centre of the sun as the stationary point o the universe. The arguments in favour of this new view occupy a relatively small portion of the work and the greater part is concerned with description of the movements of the celestial circles, with mathematical theorems, and with astronomical tables which were intended to supersede the earlier collection While his tables were an improvement on the olde tables, they soon became obsolete under the observational work of Tycho Brahe, and in the light o present-day knowledge the accomplishments c

Copernicus seem very small. He merely assigned the diurnal motion to the rotation of the earth, and the annual motion to its revolution round the sun, and from these postulates he worked out the astronomical consequences by means of the old devices of eccentricities and epicycles. A certain amount of simplification was introduced into the Ptolemaic scheme by reducing the necessary number of circles from about eighty to thirty-four, and in addition, credit is due to Copernicus for improving the elements of the planetary orbits. It is difficult for us now to understand why such a book—far from objectionable on religious grounds—should have been declared heretical sixty-three years after the death of Copernicus and placed on the Papal Index, from which it was not removed until 1835. The reasons for this step are interesting in view of the fact that the Church at first offered no opposition to the views of Copernicus.

When the stars were believed to move round the earth the universe could not be considered infinite; such a conception would imply that some stars were moving with infinite velocity to complete their diurnal course. When Copernicus transferred the diurnal motion to the earth there was no fundamental objection to infinite space, and this challenged the existing philosophy of Christianity. The Church held that there could not be an infinite material universe, with no abode of the blessed beyond the outermost sphere, and hence the views of Copernicus were a potential source of heresy. Even in the days of Bruno the discoveries of Copernicus were unhinging men's minds, and this little world was regarded in a new light. The new learning was easily used as a lever to displace the antiquated system which had come down from Aristotle.

It is not easy to decide definitely about the view of Copernicus himself on these matters, or to discover whether he considered his system a real account of the universe or merely a calculating device. Arguments can be adduced in favour of either opinion, but, as Prof. Dingle pointed out, at the time of the next centenary of "De Revolutionibus", it will be difficult if not impossible to understand what all the controversy was about. The question is: "Is a scientific explanation of a phenomena the real ruth ?" Assuming that two different mathematical descriptions of a physical situation are equally consistent with the facts, which is the true one ? A definite general answer has been given in the present century, and that is that the aim of science is to save he phenomena; in other words, to find a rational connexion between the observations. When this is done, he word 'real' or 'true' is a meaningless label, and of the two descriptions assumed we may adopt whichever we wish.

In the days of Copernicus this answer had not been formulated, though its validity was admitted n very obvious cases. Whatever may have been his own view of his work, we see it now as one of the greatest landmarks in scientific history, and without t the work of Kepler and Newton, and hence of modern dynamical astronomy, would have been mpossible.

Many find it difficult to understand how an riginal thinker like Copernicus could accept the metaphysical principles which seem so baseless to-day. n answer, it may be pointed out that consistency is not a *sine qua non* of greatness, for if it were, the first reat man has yet to be born. Millions at present believe that three independent persons are yet one God, but many of these allege that physics is talking nonsense when it suggests that a wave and a particle are yet one electron. Copernicus has one outstanding distinction, even if he was unable to free himself completely from illusions. In an age when even the greatest were unable to escape from astrological speculations, he alone transcended them altogether. He undertook the complete reform of astronomy, the erasure of the product of two thousand years of toil, and a rebuilding of the whole edifice, and he takes his place among the great original thinkers of history.

CO-ENZYMATIC REACTIONS

By Prof. J. K. PARNAS

Member of the Academy of Sciences of the U.S.S.R.

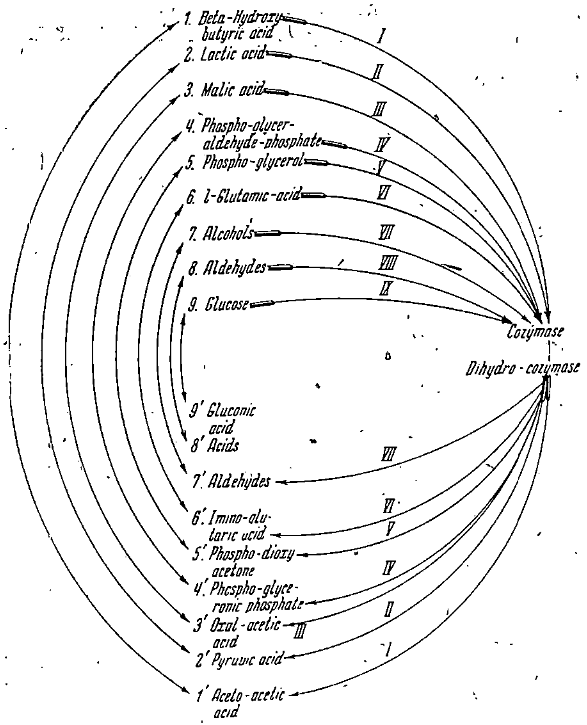
THE development of biochemistry, during the last two decades, has largely increased the number of known components of organisms, and beyond discovering them and surveying their distribution, biochemistry was able to assign to many formerly known and newly discovered substances their part in the structure of living matter, their part in the chemical reactions occurring in cells and tissues, and in the regulation of the functions of the organs. The large increase of our materia biochemica was proceeding simultaneously with the elucidation of the mechanisms of biochemical reactions, which appear, now, quite different from what could be imagined twenty years ago; not only in the complexity of the intermediary transformations leading to the final products, but especially as concerns the nature and the numbers of reagents—of the organism's own reagents, of course —taking part in them.

Many chemical transformations which take place during the metabolism in cells and tissues have been resolved, indeed, into series of intermediary reactions, linked together in such a way that the products of earlier reactions are transformed in later ones: the final balance of the series gives the equation of the transformation of initial substrates into final products. Of the products of intermediary reactions, some become substrates of the reactions which follow, others appear as final products in the balance. Such intermediary reactions which cannot be resolved into series of two or more may be claimed to be primary reactions; this claim is not, however, a conclusive one, because further research may reveal as a balance of a complicated series even such reactions which at present do appear simple enough to be primary ones. The investigation of enzymatic reactions with pure isolated enzymes and co-enzymes may be considered at this moment to be the most promising tool for resolving balances of biochemical series into primary reactions.

The ideas concerning co-enzymes and co-enzymatic reactions are given here in short. They represent the views of the present author, and are entirely different from the views held by O. Warburg and by H. von Euler, and others[1].

The primary reactions are sometimes much more complicated than final balances. This is so, because not only initial substrates are transformed in them, and such intermediary substrates which are derivations of the initial, but also substances which are not related to the initial substrates, and which do not appear in the final balance, because after disappearing in some intermediary reactions they are regenerated out of their transformation products in some later ones. Such substances are called co-enzymes: they are partners of some primary bimolecular enzymatic reactions, and their role may be compared with the role of nitric acid in the lead-chamber process of sulphuric acid manufacture.

Co-enzymes participate in primary reactions as individual substrates, together with substances which are derivatives of the initial substrates. Their co-enzyme character does not appear but in the series. Each co-enzyme is a member of a co-enzymatic system, composed of at least two closely related substances, the particular co-enzymes of one system appearing and disappearing in turn in the consecutive steps of the series.



The following are the well-known co-enzyme systems of cellular and tissue metabolism:

(1) *Cozymase*[2] and *dihydro-cozymase* concerned with electron and proton transfer (from initial and intermediary substrates) in very many anaerobic and aerobic reactions. (2) *Phospho-cozymase*[2] and *dihydro-phosphocozymase*, taking part in not so many electron transfers, so far as is known. (3) *Adenosine-monophosphoric, adenosine-diphosphoric, adenosine-triphosphoric* acid, concerned with transphosphorylations in animal tissues. (4) as (3), but including *adenosine*, concerned with transphosphorylations in yeast. (5) *Ornithin-citrulin-arginine*, concerned with urea formation and transamidination. (6) α-keto-glutaric acid-*l* glutamic acid, concerned with transaminations. (7) Riboflavine-adenine-dinucleotide, dihydro-riboflavine-adenine-dinucleotide, concerned with certain steps of electron and hydrogen transfer. (8) Thiamin diphosphate, concerned with anaerobic and aerobic decarboxylations. (9) Succinic acid-fumaric acid, as (7). (10) Malic acid-oxaloacetic acid, as (7) and (9).

Co-enzymes react as well as substrates inside the reactive complex, which they form with the enzyme and its activators, according to the general principles of enzymatic kinetics. Two kinds of co-operation between enzyme and co-enzyme are known.

(1) Both substrate and co-enzyme are linked to the enzyme during the reaction, but after the transfer of electrons, atoms or groups from or to the co-enzyme, both newly formed derivatives part from the enzyme. The co-enzyme, afterwards, is regenerated out of its product in another enzymatic act, in which it reacts with another enzyme and another substrate This is the case with co-enzymes 1–6, probably also with 9 and 10.

(2) The co-enzyme remains attached to the enzyme and it oscillates, for example, between its hydrogenated and dehydrogenated form—without parting from its enzyme. The two forms—say, K' and K''—react in co-operation with the same enzyme, in turn with two substrates, and are regenerated to the previous state in the second reaction. This is the case with flavine co-enzymes: the complexes (co-enzyme enzyme) have every likeness to the enzymes with fixed prosthetic group.

We may call the first group of co-enzymatic systems polyenzymatic or mobile, the second monoenzymati or fixed co-enzymes. The oxido-reductions, as occurring, for example, in the liver, where *beta* oxybutyric acid; lactic acid, malic acid; phosphoglycerol; phosphoglyceraldehydephosphate; glutamic acid; glucose; aldehydes; alcohols are reversibly dehydrogenated by specific enzymes and cozymase and with formation of dihydrocozymase to aceto-acetic acid; pyruvic acid; oxaloacetic acid phosphodioxyacetone, phosphoglyceric phosphate keto-glutaric acid; gluconic acid; acids; aldehyde respectively are an example of a group of co-enzyme linked reactions.

In such groups of co-enzyme linked reactions—a may be seen in the diagram—the hydrogen transported by a specific enzyme from any one of the donors to the co-enzyme may pass from the dihydro co-enzyme to any one of the dehydrogenation products, acting as acceptors. What happens depends of course, on the affinities and conditions, but the ways are made practicable and the activation barrier can be overcome.

The analysis of a biochemical reaction will not be completed until even the ultimate reactions between the enzymes themselves and the substrates of the primary reactions are elucidated. This is a matter fo future research. For the present we are concerne with such primary reactions including the transformations of substrates and co-enzymes the stoichiometric equations of which can be formulated. Bu as the co-enzymes belong to the catalytic systems their transformations disappear in turn; and it ma be useful to introduce another unity of transformations of metabolites, in which the co-enzymes do no appear. We shall consider, in the present article, suc balances of smallest sets of co-enzyme-linked primar reactions from which the transformations of th co-enzymes taking part in these reactions disappear we shall call them minimum balances.

The minimum balances correspond to what coul be considered as primary reactions of intermediar substrates, before the co-enzymes and their participation in the metabolic reactions were known.

It is interesting to consider the catalytic possibiliti in co-enzyme-linked enzyme groups. Take a co-enzyme-linked group with n hydrogenated (Red.) an n dehydrogenated (Ox.) partners, where every O corresponds to some one of the Red., and vice versa; and with n specific enzymes to meet. How many minimum balances can be brought about by such a system? The number of reversible minimum balances in such group (m) is given by the equation $m = \frac{n(n-1)}{2}$. One minimum balance is possible when $n = 2$, three when $n = 3$, six when $n = 4$, ten when $n = 5$, and so on.

Should the reactions between the n Red. and n Ox. be catalysed directly by non-co-enzymatic enzymes and not co-enzyme-linked balances, then $\frac{n(n-1)}{2}$ enzymes would be required, namely, as many as there are reactions possible. This gives one enzyme for a set of $n = 2$, which is less than required for a co-enzymatic transfer; three enzymes for $n = 3$, which is the same as for co-enzymatic transfer; but for groups larger than 3 the number of enzymes required for non-co-enzymatic transfers becomes greater, and much greater than for co-enzymatic transfers, increasing just as the number of possible reactions between the n Red. and n Ox.

If the transfer goes on irreversibly between n donors and m acceptors, the acceptors being not directly related to the donors, the number of possible reactions and of enzymes needed for direct transfer is $(m \times n)$; when there is an intermediary co-enzyme system in common, then the number of enzymes needed is $(n + m)$.

Taking a more general example: for direct transfer by enzyme action of electrons or groups from n donors to n acceptors, none of the latter being a derivative of some one of the donors, n^2 reactions are possible, and such a number of enzymes would be required should the enzymes be specific. Should the transfer, however, proceed through one common co-enzyme system, that is, the group transferred pass first to the co-enzyme K', changing it to K''; and then from K'' to the several acceptors; then only $2n$ enzymes are needed; that is, n for the transfer from n donors to K', and n for the transfer from K'' to the n acceptors.

As stated above, in groups of co-enzyme-linked reactions larger than 3, every enzyme participates at more than one minimum balance. The number of minimum balances in excess of one for one enzyme s, of course: $S = \frac{n-3}{2}$.

To n = 2, 3, 4, 5; 6 ....10 corresponds
s = −0·5, 0; 0·5, 1, 1·5 .... 3·5
m = 1, 3, 6, 10, 15 45

Large groups of co-enzyme-linked reactions are known to occur in muscle, liver, yeast, the cozymase system being the link; smaller groups for phosphocozymase, and for the adenosine-polyphosphoric acids. The largest known is probably the group of aminopherases, linked by glutamic or aspartic acid in animal and plant tissues respectively. These aminopherases are not yet resolved into individual specific enzymes corresponding to individual monocarboxylic -amino-acids each. But take, for example, the case of ten amino-acids exchanging amino-groups. Should there be specific aminopherases for direct exchange between ten amino-monocarboxylic acids and ten -keto-monocarboxylic acids, the latter not being derivatives of the first, then 100 such enzymes would be required, while only twenty are required for aminopheresis through the intermediary of the co-enzymatic systems of monoamino-dicarboxylic acid.

It makes no difference to the role of co-enzymes in co-enzyme-linked groups, whether they are mobile or enzyme-fixed: but the fixed co-enzymes are essentially monoenzymatic in their physiological function. Of course, flavine-adenine-dinucleotide is involved in a certain number of different transformations: in the oxidation of dihydrocozymases, in the oxidative removal of d-amino-acids, and in oxidation of xanthine; and dihydro-flavine-adenine-dinucleotide does participate in hydrogenation of fumaric acid too. These reactions are not, however, reversible ones: the first brings the hydrogen of substrates into the final path of oxidation, the second participates in the stereochemical rearrangement of amino-acids not by returning electrons and protons to the ketoacids, but passing them to the oxidation path. The fixed co-enzymes are not physiologically polyenzymatic, and this is characteristic for the very pathway of oxidations in which they participate. The polyenzymatic function of mobile co-enzymes is most important for fermentations and for the anaerobic part of the aerobic reactions.

It is interesting to consider the specificity of co-enzymatic reactions. Take the case in which the enzymes of co-enzymatic reactions are strictly specific, as it occurs with the hydrogenopherases of the cozymase-linked group; it is well known that the lactic hydrogenopherase, isolated by Straub in pure crystalline form, does not act on malic acid and cozymase. In a system containing lactic acid, hydrogen from lactic acid goes to oxaloacetic acid: this is the principle of co-enzyme-linked reactions. In larger groups of co-enzyme-linked reactions the substrate-specificity of the enzymes in co-enzyme-linked groups places them as to the degree of specificity in a position intermediate between the exclusively substrate-specific enzymes and the enzymes possessing group-specificity. The specificity of enzyme actions *sensu strictiori* does concern primary reactions; it holds good for minimum balances in sets of two and three co-enzyme-linked groups; it fades away in larger groups.

It is interesting, also, to consider the way in which co-enzyme-linked groups of enzymatic reactions may be linked one with the other. Three reactions are known to occur in the liver in which the co-enzyme may be either cozymase, or phosphocozymase, namely, the oxidation of glucose of l-glutamic acid. This means that the electrons of these substances may pass either to the acceptors of the cozymase-linked group or to the acceptors of the phosphocozymase-linked group; and the entire mobile systems of the co-enzyme-linked groups of similar reactions do become linked through common substrates. The number of sets of two reactions from which the co-enzyme system disappears equals the product of such minimum balances of the two groups, when the substrate in common is taken into account for each of both groups; but minimum sets involving both co-enzyme systems must contain not less than four reactions.

The meaning of the parcelling even of the elementary metabolic act of combustion of 2H into many consecutive steps was most clearly explained by Szent Györgyi; the meaning of the intermediaries in metabolic transformations, by the comparison with waterways and sluices in them, was aptly explained by H. Borsook. In the present article I have tried to bring into prominence a feature of co-enzymatic reactions, which has not, so far as I know, been noticed until now. It is the role of polyenzymatic co-enzymes in bringing electrons, atoms or groups into one collector, and distributing them further in an exergonic way, to organic acceptors, in fermentations and in the anaerobic part of aerobiosis, or to fixed co-enzymes of the pathway of oxidation, in the aerobic part. They are a part of the catalytic apparatus of organisms which contribute to such a co-operation of specific enzymes by which these enzymes, without losing their specificity in the primary reactions they catalyse, are able to perform each more than one transformation of the metabolites.

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[1] For a more comprehensive review, see Parnas, J. K., Glykogenolyse, Hdb. d. Enzymologie (Nord u. Weidenhagen, 2, 902–967, Leipzig 1940, or Ouspechi Sovrem. Biologii, U.S.S.R., 12, 393, 1940), also the article by W. Franke in the same volume. Also: D. E. Green, "The Mechanisms of Biological Oxidations", London, 1941.

[2] Synonymous with what is called by different authors 'co-enzyme I' and 'co-enzyme II', or 'codehydrase I and codehydrase II', or 'pyridine' or 'pyridine-nucleotide'. Cozymase was discovered by Harden and Young, given this name, and investigated, under the same, in numerous papers by von Euler and Myrbäck. There is no reason for giving a substance a new trivial name after the isolation and elucidation of its structure. Phospho-cozymase is a logical extension of the name cozymase for its derivative containing one phosphate group more.

BOTANY IN INDIA

By Sir GEOFFREY EVANS, C.I.E.

AT the thirtieth Indian Science Congress held in Calcutta early this year, the Section of Botany was presided over by Dr. Kalipada Biswas, director of the Royal Botanic Garden, Calcutta. In his presidential address, which is entitled "Systematic and Taxonomic Studies on the Flora of India and Burma", Biswas dealt very fully with many aspects and covered such a wide range of subjects that it is obviously impossible, in the limited space available, to attempt more than a general summary.

In the opening stages of his address, an account is given of the history of systematic and taxonomic researches in India. The investigations, on lines followed by Western countries, can be divided into three main periods. The first period was from 1768 until 1848 and started with the pioneer work of Koenig, who was the first to introduce the Linnean system into India. Great encouragement to the work was caused by the foundation of the Royal Botanic Garden at Sibpur, Calcutta, in 1787, by Colonel Robert Kyd, who was honorary superintendent of what was then the East India Company's Garden, and it was after Roxburgh had succeeded Kyd on the latter's death that botanical researches on a proper basis may be said to have become properly established in India. The manuscripts of "Flora Indica" and "Hortus Bengalensis" were completed by him between 1794 and 1813, and he was rightly known as the Father of Indian Botany.

The second period begins about 1846 with the first visit of Sir Joseph Hooker. This was a great period for botanical exploration and collection, and is full of the names of many famous botanists who made valuable contributions to both systematics and the enhancement of the plant collections in the Sibpur Herbarium, and also to the interchange of specimens with Kew and other famous herbaria.

Full tribute is paid to the long list of illustrious names of famous botanists who have in turn ruled over the destinies of the Royal Botanic Garden in Calcutta and done so much to foster botanical research. Biswas points out how, until quite recently, nearly all the original work has been carried out by Europeans and that only about 30 per cent of work published has been contributed by Indians. He asserts that very few members of the staff of Indian universities take any interest in systematic and taxonomic studies, preferring to devote their attention to those other branches of botanical research that can be carried out in laboratories, rather than the undertaking of prolonged field work and subsequent determinations of the plants collected. One of the results is that Indian workers on systematics are now mainly confined to Government institutions in Calcutta or at Dehra Dun, which is the headquarters of the Forest Service.

This lack of trained botanists is to be deplored in view of the wide field that awaits investigation, a point that is clearly brought out by a map showing the large areas that are unexplored or only partially explored from the botanical point of view. In many areas the larger flowering plants have been well worked over, but it is particularly the smaller and more primitive forms of plant life that now need attention. The Indian Botanical Departments have hitherto surveyed mainly the higher forms of plant life; but the primitive forms have an equally important significance to the plant geographer and the general botanist. Dr. Biswas touches on this latte point in his section dealing with mangrove swamps, which he divides into regions according to species and to their algal associations, which are said to be characteristic.

In the main body of his address he deals with th vegetation of the rain forest regions of Eastern Indi and Burma, enumerating the chief species tha constitute the various strata in forest of this type Later on he deals with the effect of altitude on plan growth and the characteristic species of the easter Himalayas. He suggests that the Abor country o northern Assam might prove to be particular suitable for the study of questions concerning th ecology and geographical distribution of plants.

A considerable portion of the address is occupie in a discussion of the different elements that compris the Indian flora. He quotes Dr. Chatterjee's estimat that more than 61 per cent of the plants are endemi and gives his own figure for the Sikkim Himalay in the Darjeeling district alone as 50 per cent indigenous to the Himalaya, the rest being foreig species from other parts of Asia, America and Europ and a few from Australia. Many of these have n doubt been introduced either deliberately in cultivation or accidentally by trade routes, within comparatively recent times.

Dr. Biswas discusses the modern trend of systemati and taxonomical studies and traces the history o botanical study, stating that it received the attentio of the Hindus more than 2,500 years ago. Plant were used by the ancient Rishis and sages in Indi in connexion with various rituals. Later on, plan were studied in relation to agriculture and horticu ture, and medicinal plants receive particular attentio in the Ayurveda. He thinks it not unlikely that th knowledge of plants spread gradually from Hindusta to Europe via Arabia, Syria and Greece. There little doubt that botanical knowledge in Euro advanced through the herbalists. For exampl d'Alechamps recognized eighteen classes of plants according to their medicinal properties. As knowledge increased, the classification of plants took its proper form in the hands of De Candolle and Linnæus, and as a result of their work it has now reached its present high standard. It is still a matter of dispute as to the perfect system of classification and the best method of describing the plant. The idea, held until comparatively recently, that systematics consisted of a specialized and rather narrow branch of biology, empirical in character and without general application to other branches of science, is now recognized as out of date. Recent investigations of workers devoting their attention to morphology, ecology, anatomy, genetics, cytology and plant breeding can now be utilized correctly to stabilize the systematic position of a particular plant. In other words modern thought tends to the opinion that systematics must now be studied in relation to general biology.

As has already been mentioned, Dr. Biswas has covered a very wide field dealing with many different aspects. Possibly it would have been better if he had confined his discussions to a more limited field so as to bring home to the public his main point, which is the special need for more botanical research. No one can cavil at his plea for more development in this direction. India now has her destiny in her own hands. In the past most of the systematic work in botany was carried out by Europeans who have well and truly pointed the way, but now the "mantle of Elijah" has fallen on Dr. Biswas and his associates, and they are naturally anxious that progress should not be delayed.

The scope for systematic botany in India, as he has pointed out, is enormous. Many unknown or little-known plants await discovery, and many of them are doubtless of commercial, medicinal or agricultural importance. The part that systematic botany may well play in the economic side of development has been mentioned in the address, but might well have been reviewed even more fully as it plays an important part in deciding the actions of Governments. It has also proved its value during the present War when so many new products and so many substitutes have had to be found to cope with war-time shortages and demands. Let us hope that botany, and in particular systematics, will take a more leading part in the life of the Indian universities than apparently has been the case in the past, and also that private citizens may be found who will undertake work of this kind as a matter of choice. In Great Britain much work has been carried out by individuals in a private capacity. It has supplemented the organized work of the universities and the scientific departments of State, and has resulted in valuable accumulations of our knowledge of plants. This is a line of work that might with advantage be followed in India in the future.

OBITUARIES

Prof. Warrington Yorke, F.R.S.

As proof that any man of science enjoys fame extending beyond the limits of his own country, we have at our disposal one rather delicate test. The printed word has, of course, great value in this respect, and there is no doubt that publication of papers by foreign journals denotes a quite definite recognition of a man's status by his colleagues abroad. But it is when members of learned societies in other countries have become so interested in a man's work that they desire to see him in person, and hear him for themselves, that it may most truly be said that he has achieved an international reputation in his subject.

Warrington Yorke had attained that degree of eminence. This is evident from the number of his lecture engagements abroad, of which the following may be mentioned. In the year 1933 he lectured on chemotherapy to the members of the Medical Academy in Düsseldorf; in 1934, at the International Malaria Congress in Rome, he read a paper entitled "A Contribution to the Biological Side of Chemotherapy"; in 1939, at the Third International Congress for Microbiology in New York, he gave an address on "Recent Work on the Chemotherapy of Protozoal Infections". During the same period he was also greatly in demand as a lecturer at home. He addressed the Medical Society for the Study of Venereal Disease on "Drug Resistance" in 1933, the Royal Society of Tropical Medicine and Hygiene on "Chemotherapy in Protozoal Infections" in the same year, and also in 1935; the Chemical Society of Liverpool on "Chemotherapy" in 1940, and the Biochemical Society of London on the "Diamidines" in 1941.

A perusal of the above titles might lead the reader to suppose that Yorke had always specialized in the application of drugs to the treatment of disease, and certainly the high standing which he enjoyed as an exponent of chemotherapy would justify this supposition. But in fact his enthusiasm for this subject was a comparatively late development. It originated when, in 1929, he discovered a method by which the pathogenic trypanosomes which affect man and animals could be kept alive outside the animal body. This discovery placed in his hands a ready means by which he could study the effects of drugs on some of those protozoal parasites which cause disease in man. The fact that parasites treated with doses of certain drugs, insufficient to kill them, might develop a remarkable resistance against the effects of further and larger doses of the same drugs, was of fundamental importance in the drug therapy of such diseases as sleeping sickness. Of even greater biological significance, and of no less practical importance, was the discovery that such drug resistance, once acquired by the parasite, might persist even while the parasite was passing through its curious development in the vector. For example, an arsenic-fast strain of trypanosome would still possess its acquired arsenic-fast character even after the trypanosomes had completed their cycle in the body of the tsetse fly. But the discovery of the technical device mentioned would never in itself have enabled a man to advance his subject in such a notable manner as Yorke succeeded in doing. It was on account of the great knowledge and wide experience of tropical diseases he possessed, which he had acquired during many foregoing years of arduous work, that he found himself in a position to take the fullest advantage of this discovery.

Warrington Yorke was the son of the late Rev. H. Lefroy Yorke, and was born at Lancaster in 1883. He attended University School, Southport, and Epworth College, Rhyl, and was a student at the University of Liverpool, where he took his medical degree in 1905. He went out to Nyasaland in 1907 to study blackwater fever and was there for two years. In 1911–12 he was again in Africa, this time on a sleeping sickness commission in Northern Rhodesia; in 1914 he was on a similar commission in West Africa. During 1914–29 he held the chair of parasitology at Liverpool, and he was then appointed to the chair of tropical medicine which he occupied until the time of his death on April 24. In 1925 he was awarded the Chalmers Memorial Gold Medal of the Royal Society of Tropical Medicine and Hygiene, and in 1932 he was elected a fellow of the Royal Society.

He married in 1916 Elizabeth Annie Greening and they had two children. He is survived by his wife, a son, now unfortunately a prisoner in Japanese hands, and a daughter. D. B. Blacklock.

Prof. Warrington Yorke knew before the end of last year that he had an inoperable cancer which would be fatal within a few months. Despite this knowledge, he undertook a mission to the United States on behalf of the Medical Research Council and returned with valuable information. Also he undertook to give the Croonian Lecture at the Royal Society on July 15 in the hope that he would live long enough to accomplish it. The title of the Lecture was to be: "Recent Developments in Chemotherapy with Special Reference to Tropical Medicine".

Personally I class his untimely death in the same category as deaths of men 'killed in action', and I recall to myself the brave words written by Robert Louis Stevenson in "An Apology for Idlers"—I believe they were:

"Even if the doctor does not give you a year, even if he hesitates about a month, make one brave push and see what can be accomplished in a week."

S. P. James.

Mr. W. Trevor Watson, K.C.

William Trevor Watson, who died in his fifty-seventh year on March 24, graduated in the honour school of physics at Oxford in 1909, holding a senior mathematical postmastership at Merton College. In 1911 he was called to the Bar by Gray's Inn, taking a first in the final examinations, and all the prizes that were to be had. He became a pupil and, later, 'devil' of J. Hunter Gray, who at that time was the busiest junior specializing in patent law. During the War of 1914–18 his scientific capabilities were quickly realized and he was transferred from the Worcester Regiment to the R.F.C., where he played a large part in carrying the infant art of wireless telephony to the operational stage between aircraft and ground. A crash suffered in this work undoubtedly had some ill effect upon his health in later life, for he was never physically robust.

On his return to chambers, Watson at once found himself very busy, as he appeared day by day to represent the Treasury in claims before the Royal Commission on Awards to Inventors; in addition, his services were in constant demand in patent litigation in the High Court and in opposition proceedings before the Comptroller of Patents; moreover, he made a reputation as an expert in trade mark and copyright law. He took silk in 1930.

The characteristics which made for his great success were a clear and exceedingly alert mind, keen judgment of the relevant, the gift of explaining difficult scientific matters to those who knew less than he did, and often nothing, while avoiding an air of pedagogy, together with a dignified courtesy to Court and to opponents. He had also a very retentive and accurate memory and the Court accepted without question any statement of the law which he propounded, knowing that he could give chapter and verse without hesitation.

A brief outline only can be given of the scientific detail Watson had to master in the cases he fought, and even this must be incomplete, since no reference can be made to the many problems brought in consultation to his chambers and solved without recourse to litigation. Most of the important inventions of the last twenty years were brought to him for advice at some stage or other. It must be remembered that the understanding of a particular invention is only a minor part of counsel's scientific equipment; he must appreciate so much of the 'common general knowledge' of those skilled in the particular industry that he can evaluate the inventive step which has been made.

The breadth of his knowledge is, perhaps, exemplified by the many inventions brought to the Royal Commission on Awards to Inventors; for example, various radio problems, aeroplanes, mustard gas manufacture, torpedos, paravanes, machine-gun-propeller synchronizing, bomb sights, mortars, grenades, tanks, gyroscopic controls of various kinds. Of his patent cases, mention may be made of the electric lamp cases, the leading-in wire, the coiled-coil filament and the internally frosted globe patents; of the wireless cases, the grid bias and the pentode patents; of the sound-film cases. In the chemical industry, he was concerned in all the rayon litigation, in the hexyl resorcinol case, in the azo-dyestuff case (which established that there may be invention in 'selecting' from a known group for an exceptionally useful purpose), and in the only biochemical case which has come before the Court, the fermentation process for the manufacture of acetone. He also helped to decide whether calcium carbide is legally a synthetic organic chemical or not. Whatever the scientific subject, experts who were cross-examined by him sighed with relief when the battle of wits was concluded and he sat down.

Watson was also a specialist in trade mark and copyright law and was a member of the commission on the advice of which the present trade mark law is founded—though in several respects he disagreed profoundly with the drafting of the present Act.

He remained at all times modest, a delightful companion and interesting talker on many subjects. All who knew him at all well referred to him affectionately as 'Trevor', so that clients have even been known to think he was Mr. Trevor. In later years he took to golf with that thoroughness and competence which he gave to all he undertook. The War made it necessary for him to leave his country house adjoining the North Foreland links, and lack of exercise, the destruction of his chambers in the Temple and the grievous strain of heavy mental work under war conditions impaired his health to the detriment of his accustomed forensic power. It was a great joy to his many friends that in his last case in the House of Lords he recovered all his brilliance, to which the Lord Chancellor, in giving his judgment delivered after Watson's death, made a generous reference. G. S. W. Marlow.

NEWS AND VIEWS

Copernicus and his Influence on Astronomical Thought

It is just four hundred years since Copernicus died. A very short time before his death the first printed copy of his work, "De Revolutionibus Orbium Coelestium", was placed in his hands, but in his semi-conscious state he was unable to realize the implications of his views expressed in his book, or the revolution which they were destined to effect in scientific thought. Before his time the Aristotelian scheme of cosmology was generally accepted—the earth being the centre of a system of spheres, to which the planets were rigidly attached. Outside this system was another sphere to which the stars were attached, and this sphere, with the stars, rotated once in twenty-four hours. To account for the erratic motion of the planets it was believed that the planetary spheres rotated in a direction opposite to that of the sphere of stars, but were dragged along by the superior force. Saturn was then considered the outermost planet and therefore nearest to the stellar sphere; for this reason it had the greatest difficulty in overcoming the force of the stellar sphere, and hence required a long time to complete a revolution. In contrast with Saturn the moon—the nearest to the centre—had little force to overcome and so completed a revolution in the least time.

Such, in brief, was the system which Copernicus found when he took up the study of astronomy, and it is against the background of such a cosmology that we must judge his greatness to-day. He introduced simplicity into the generally accepted scheme by postulating a rotation of the earth once in twenty-four hours and an annual motion round the sun. By means of the old devices of eccentricities and epicycles and these two postulates, he worked out the astronomical consequences. Among the ancients there were some who had taught that the earth was in motion, but their ideas were mere philosophical speculations, and they had not developed them into a systematic scheme. To Copernicus alone belongs the honour for the heliocentric scheme which was destined to revolutionize the course of astronomy. In another part of the present issue there appear two synopses of the life and work of Copernicus, which demonstrate the debt that the world of astronomy owes to one who stands out as a great thinker and who made possible the developments which afterwards took place under Kepler and Newton.

Sylvestre-Francois Lacroix (1765–1843)

In his "Passages from the Life of a Philosopher", where he refers to the works he studied at Cambridge, Charles Babbage said: "In 1811, during the war, it was very difficult to procure foreign books. I had heard of the great work of Lacroix, on the 'Differential and Integral Calculus', which I longed to possess, and being misinformed that its price was two guineas, I resolved to purchase it in London on my passage to Cambridge. As soon as I arrived I went to the French bookseller, Dulau, and to my great surprise found that the price of the book was seven guineas. After much thought I made the costly purchase, went on immediately to Cambridge, saw my tutor Hudson, got lodgings, and then spent the greater part of the night turning over the pages of my newly-acquired purchase".

The author of this work, Sylvestre-François Lacroix, was for more than half a century one of the foremost teachers of mathematics in Paris, in which city he was born and died. His death took place on May 25 a century ago. A pupil of Monge, his first appointments were in naval and military schools, and then in 1794 he was given an important post in connexion with the re-organization of public instruction. He also held a chair in the short-lived Ecole Normale, and afterwards held professorships at the Ecole Polytechnique, the Collége de France and the Sorbonne, at the last of which at one time he had as colleagues Biot, Poisson, Francœur and Hachette. His book on the calculus was but one of several of his mathematical text-books, but it was probably the most important. Having read his own copy, Babbage drew up a sketch of a society to be formed for translating an earlier and smaller work by Lacroix on the same subject, and thus the Analytical Society came into existence in 1813, Herschel and Peacock being among Babbage's chief supporters. The Society published its translation of the "Traité élémentaire" in 1816, and in the following years the differential notation made its appearance in university examinations.

Smithsonian Institution

The report of the Secretary of the Smithsonian Institution for the year ending June 30, 1942, includes the financial report of the executive committee of the Board of Regents, together with a summary of the year's activities and reports on the United States National Museum, the National Gallery of Arts, the National Collection of Fine Arts, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Observatory, the Division of Radiation and Organisms and on the Library. A War Committee has been appointed to facilitate the assistance of the war effort by the Institution, and in addition to preparing a detailed roster of the scientific staff, an index has been compiled of published and unpublished photographs taken by the scientific members of the Institution in all parts of the world for ready consultation by war agencies. Together with the National Research Council, the American Council of Learned Societies and the Social Science Research Council, the Institution has participated actively in setting up the Ethno-geographic Board. Under the editorship of Dr. Julian H. Steward of the Bureau of American Ethnology, the Institution has undertaken the publication of a handbook on the Indians of South America.

Another important Smithsonian publication will be a list of the insects of South and Central America, which will be a much-needed tool for future entomological work in these areas. The specialized geographical, racial and linguistic knowledge of the scientific staff of the Bureau of American Ethnology has been in constant demand by the Army, Navy and other war agencies, but the work of the International Exchange Service has continued to be greatly hampered by the War. The most important event of the year of the Astro-Physical Observatory was the publication of vol. 6 of the *Annals*, covering 1920–39. This volume is the culmination of seven years work on revision of the daily results of observation of the solar constant of radiation at the three field observing stations. The Division of Radiation and Organisms has continued its work on the factors that influence the change in rates of respiration in plants. The study of the relation between light intensity and inhibition of growth of the oat mesocotyl was extended to higher intensities. Work is in progress on the isolation and separation of two pigments which occur in dark-grown oat seedlings. Since October 1942 the Division has done war work only.

Regional Boundaries in Great Britain

The Association for Planning and Regional Reconstruction has issued a broadsheet dealing with the regional boundaries of England and Wales. This is of particular interest at the present moment, for it includes a series of maps, the first of which shows the civil defence regions related to a composite of boundaries comprising those of the Ministry of Labour and National Service, the Ministry of Transport, the Ministry of Food, the Board of Education Inspectorate, the Home Office Factory Inspectorate, and the Ministry of Works Contractors Regions, the Ministry of Agriculture Advisory Provinces and Statistical Divisions, the Board of Trade Census of Production 1935 areas, those for the Registrar-General for the Census, and the Post Office regions. The five remaining maps show the divisions suggested by Prof. C. B. Fawcett in 1942, Mr. John Dower in 1938, Mr. E. W. Gilbert in 1941, Prof. E. G. R. Taylor in 1941, and Mr. E. A. A. Rowse in 1941, respectively.

Vitamin Content of Brazilian Foods

According to the *Journal of the American Medical Association* of February 20, Dr. Moura Campos, professor of physiology at the University of São Paulo, is conducting a series of researches on the vitamin content of Brazilian foods and on the practical importance of the different vitamins. In a recent paper he showed that thiamine and riboflavin act in association to help in the utilization of the food material by stimulation of the appetite and increase in the assimilation of food. His experiments prove that the presence of thiamine is necessary to the utilization of riboflavin. Thiamine alone cannot maintain the growing capacity. Mandioquinha (*Chœrophyllum bulbosum*) contains riboflavin but not thiamine, while goiaba (*Psidium guajava*) contains both thiamine and riboflavin. Experiments showed that the growth of rats was well maintained when they were fed on goiaba alone.

Earthquakes Registered in Spain

During January 1943 ten earthquakes were registered by the seismographs at Toledo, Spain (Registro de las observaciones provisionales correspondientes al mes de Enero de 1943. Instituto Geografico. Observatorio Geofisico de Toledo). Eight of these shocks were distant, some being rather feebly recorded and somewhat obscured by microseisms. The shock of January 7 recorded at 11h. 19m. 01s., from an epicentre some 4,445 km. distant, had a probable depth of focus of 100 km. Two shocks were somewhat local. The first, on January 9, began recording with *iPz* at 22h. 00m. 19s. from an epicentre some 318 km. distant and a depth of focus of 25 km. The epicentre was most likely in the Sierra Tejada. The second, on January 21, began recording with *ePz* at 14h. 47m. 17s. from an epicentre some 344 km. distant from Toledo and a depth of focus of 40 km. The epicentre was probably in the neighbourhood of Novelda-Monforte.

Institution of Electrical Engineers: Premium Awards

The Council of the Institution of Electrical Engineers has made the following awards of premiums: *Institution Premium:* C. J. Beaver and E. L. Davey; *Kelvin Premium:* Dr. F. Brailsford and R. G. Martindale; *John Hopkinson Premium:* Mr. R. A. W. Connor; *Non-Section Premiums:* Dr. E. Friedlander (Ayrton Premium), Mr. C. T. Melling (Llewellyn B. Atkinson Premium), Mr. J. Swaffield (extra premium); *Wireless Section Premiums:* Dr. R. L. Smith-Rose and Miss A. C. Stickland (Duddell Premium), G. Parr and W. Grey Walter (Ambrose Fleming Premium), Prof. Willis Jackson (extra premium); *Measurements Section Premiums:* Lieut.-Col. K. Edgcumbe (Silvanus Thompson Premium), M. Kaufmann and W. Szwander (Mather Premium), G. H. Barker and A. L. Hancock (extra premium); *Transmission Section Premiums:* A. W. Thompson and J. C. Wood-Mallock (Sebastian de Ferranti Premium), A. A. Pollitt (John Snell Premium), H. Willott Taylor and K. L. May (extra premium); *Installations Section Premiums:* G. B. Alvey and N. Tetlow (Crompton Premium), Forbes Jackson, W. J. H. Wood, G. Smith and E. Jacobi (Swan Premium), J. R. Taylor and C. E. Randall (extra premium); *Paris Exhibition, 1881, Premium:* J. N. Waite.

Physical Society: Officers for 1943–44

At the annual general meeting of the Physical Society held on May 18, the following officers were elected for the year 1943–44: *President:* Prof. E. N. da C. Andrade; *Vice-Presidents:* Dr. J. H. Brinkworth, Prof. C. D. Ellis, Dr. H. T. Flint, Prof. N. F. Mott; *Treasurer:* Dr. C. C. Paterson; *Secretaries:* Mr. J. H. Awbery (*Papers*), Dr. W. Jevons (*Business*); *Foreign Secretary:* Sir Owen Richardson; *Librarian:* Prof. L. C. Martin; *New Members of Council:* Prof. D. Brunt, Dr. B. Chalmers, Brigadier B. F. J. Schonland, Dr. W. S. Stiles. The chairman and secretary of the Colour Group are Mr. J. Guild and Mr. H. D. Murray, respectively; and of the Optical Group, Dr. A. O. Rankine and Prof. L. C. Martin.

Announcements

The Copernicus Quatercentenary Celebration Committee has arranged a meeting, to be held at the Royal Institution on May 24 at 3.30 p.m. in honour of Nicolaus Copernicus. The meeting will be opened by Sir Henry Dale, and addresses will be given by Prof. Stanisław Kot, Polish Minister of Information, and Dr. H. Spencer Jones.

The Council of the University of Sheffield has made the following appointments: J. T. Chesterman to be lecturer in surgical pathology and assistant curator of the Museum; Dr. John Sinclair to be lecturer in mining; and T. F. Bamber to be research assistant in mining.

The following appointments have recently been made in the Colonial Service: S. B. Kendall, veterinary officer, Tanganyika; R. K. J. Gascoigne, entomologist, Sleeping Sickness Control Service, Nigeria, to be agricultural officer, Nigeria; Dr. G. N. A. Hall, veterinary pathologist, Gambia, to be veterinary adviser, Sierra Leone and Gambia (jointly).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

New X-ray Evidence on the Nature of the Structural Changes in Cold-worked Metals

A PROBLEM in X-ray diffraction has been the diffusion of the X-ray reflexions from a metal which has been subjected to plastic deformation. A crucial experiment has long been called for which would indicate clearly what modifications in structure of the deformed metal are mainly responsible for the effect. The method usually suggested is indecisive: it involves a laborious measurement of changes scarcely greater than experimental error, and, as recent publications have shown, gives different results in the hands of different workers[1,2]. It may be of interest, therefore, to record an alternative method which, for a number of metals, including iron and steel, appears to solve the problem in a simple direct manner.

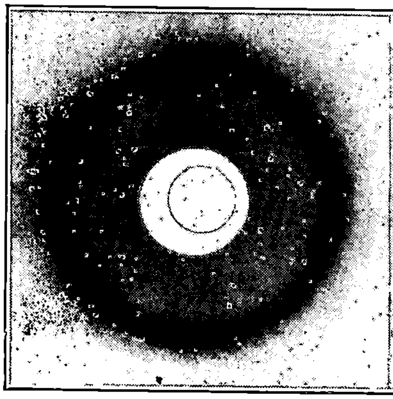

Fig. 1.

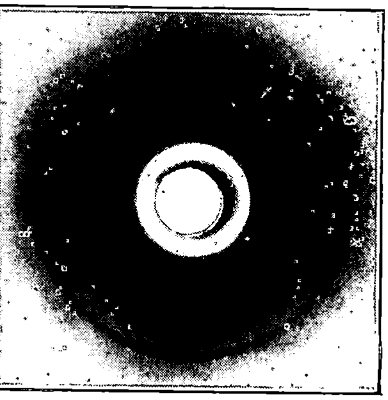

Fig. 2.

It had already been shown that the systematic deformation of metals in general produces two fundamental effects, either of which could cause the diffusion. These are: (*a*) the breakdown of the metallic grains to crystallites characterized by a lower limiting size; and (*b*) permanent overall changes in dimensions of the atomic lattice to an extent related to the external deformation of the metal[3,4]. The former factor could cause diffusion if the crystallites became less than about 10^{-4} cm. in size, when, with standard diffraction techniques, the number of atomic planes in each becomes too small to produce sharp reflexions; the latter because the lattice strain can produce an overall change in diameter of the diffraction rings, and as the lattice strain is not likely to be the same from point to point, the change in diameter will vary about a mean. Actually it was concluded from other evidence that both effects were usually present, a point especially illustrated by copper; but it was decided to try to develop a reliable criterion to distinguish the predominant factor.

The usual method[1,2] is based on the fact that, with fine crystallite size, the broadening of the reflexions formed at different angles should vary as $\sec\theta$, where θ is the Bragg angle; whereas, for variability of lattice spacing, the broadening should vary as $\tan\theta$. But, in practice, at small values of θ, when $\sec\theta$ and $\tan\theta$ differ most, the broadening is too small for reliable measurement; while at large values of θ, when the broadening does become measurable, the difference between $\sec\theta$ and $\tan\theta$ is too small to be of much use. Moreover, the necessity of having to photograph the whole angular range of the spectrum would restrict the method to a type of specimen unsuitable for serious study of mechanical deformation.

The method now used here utilizes the fact that at a given reflexion angle the broadening due to fine grain is proportional to λ, the X-ray wave-length used to obtain the diffraction pattern; but that due to variability of lattice spacing is independent of wave-length. The success of the method, however, really arises because a technique has been developed for photographing large-scale back reflexions formed by short incident wave-lengths such as molybdenum $K\alpha$ radiation without unduly long exposures, a procedure usually regarded as impracticable. It is then possible to confine attention to the large-angle reflexions, which show the broadening on an easily measurable scale. The wave-lengths normally employed to obtain back-reflexions range from 1·5 to 2 angströms. If a photograph is obtained with one of these as incident radiation and then with molybdenum radiation ($\lambda = 0{\cdot}7$ A.) or a similar short wave-length, then the broadening, if due to fine grain, will change sensitively by a factor of 2 to 3 times, well beyond experimental error.

In fact, when the main factor is fine grain, the change is so striking that it may be of interest to illustrate the effect. Fig. 1 shows the very diffuse back-reflexion (310) ring obtained from a heavily deformed steel with cobalt radiation ($\lambda = 1{\cdot}8$ A.); it is too diffuse to show the component $\alpha_1\alpha_2$ doublet. Fig. 2, in contrast, shows a ring at approximately the same diffraction angle with the molybdenum radiation. The $\alpha_1\alpha_2$ doublet now forms rings so obviously sharper that, in any event for steel, the long-standing problem can be solved by inspection.

W. A. Wood.

Physics Department,
National Physical Laboratory,
Teddington.

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[1] Dehlinger and Kochendorfer, *Z. Krist.*, **101**, 134 (1939).

[2] Stokes, Pascoe and Lipson, NATURE, **151**, 137 (1943).

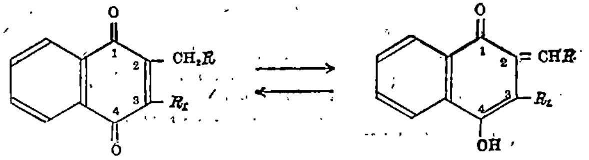
[3] Wood, *Proc. Roy. Soc.*, A, **172**, 231 (1939).

[4] Wood and Smith, *Proc. Roy. Soc.*, A, **178**, 93 (1941); **179**, 450 (1942); **181**, 72 (1942).

Mechanism of Biological Action of Vitamin K and its Synthetic Analogues

THE correlation between structure and biological action of the vitamin K group is an object of many investigations. However, in spite of much experimental material we still lack a satisfactory explanation of both the established correlations and of the mechanism of biological action of the natural vitamins K_1 and K_2 and of their synthetic analogues. It was already in 1939 that L. F. Fieser first suggested the hypothesis[1] further developed in 1941[2] that the biological activity of most analogues of vitamin K is due not to these substances as such, but to the quinones of the type of the natural vitamin into which they are transformed within the organism as a result of biological synthesis. As to the mechanism of biological action of the vitamin itself, this question remains open. L. F. Fieser's hypothesis is far from being in accord with much experimental evidence, nor does it offer a satisfactory explanation of much of it. At the same time it strikingly contradicts the notion that a perceptible, although slight, antihæmorrhagic activity is shown by phthalic acid[3]. This discrepancy is particularly noteworthy in view of the fact established in this laboratory that a high antihæmorrhagic activity is characteristic of the diethyl ether of phthalic acid (the biological assay was carried out by B. A. Kudriashev). The possibility of transformation, within the organism, of phthalic acid into compounds of the 1,4-naphthoquinone series is indeed extremely doubtful.

These observations have given some reason for assuming that the natural vitamins K_1 and K_2 as well as their synthetic analogues are only provitamins, and that their antihæmorrhagic action is due to an *oxidative biodecomposition to phthalic acid*, the latter being the true carrier of the biological function at issue. An especially conclusive argument in favour of this hypothesis is our observation made in this laboratory that such highly active analogues of vitamin K as 2-methyl-1,4-naphthoquinone and potassium 2-methyl-1,4-naphthoquinone-3-sulphonate transform extremely easily into phthalic acid even upon mere heating with water, that is to say under conditions which are most probable within the organism as well. It may be concluded from a detailed study of these transformations as well as from other properties of quinones that biological activity of both natural vitamins K_1 and K_2 and of all their synthetic analogues (derivatives of naphthalene) is actually the function of their capacity to transform into phthalic acid, while the correlations between molecular structure and biological activity can be reduced to the effect of certain structural factors on the processes resulting in the formation of phthalic acid. In our view, transformation of the natural K_1 and K_2 vitamins and their analogues into this acid is only possible in such a molecule where there may arise a tautomeric system (I) $\rightleftarrows$ (II) which is simultaneously an oxidation-reduction system



(I) (II)

where R is hydrogen or a hydrocarbon radical, and R_1 hydrogen, hydrocarbon radical or some other atomic grouping, with quinone as oxidant* transformed into hydroquinone (or into the products of further transformations of the latter), and enol (II) as reductant, finally oxidized to phthalic acid. Thus the appearance of biological activity is primarily determined by the possibility of initiation of the tautomeric system (I) $\rightleftarrows$ (II) and of a series of subsequent oxidation-reduction processes, while the effect of structural factors upon the biological activity is essentially due to their influence upon these transformations.

A discussion from this point of view of the experimentally established correlations between structure and biological activity within the group of vitamin K not only does not contradict the above concept, but also is completely confirmed by the data available. These correlations, in their turn, find an adequate interpretation.

M. M. Shemiakin.
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Dec. 16.

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* The part of oxidant is possibly played within the organism by other compounds as well.

[1] Fieser, L. F., *J. Amer. Chem. Soc.*, **61**, 3467 (1939).

[2] Fieser, L. F., Tischler, M., and Sampson, W. Z., *J. Biol. Chem.*, **137**, 659 (1941).

[3] Packendorf, K. G., Kudriashev, B. A., and Lazareva, E. N., *Doklady Acad. Nauk USSR.*, **31**, 484 (1941) (Russ.).

Counteracting Sulphonamide Inhibitors

I was pleased to learn that Tenenberg, Tsuchiya, Clark and Strakosch[1] have recently confirmed experiments which I conducted in 1940 on the effect of sulphanilamido-urea compounds on sulphanilamide-fast organisms in the presence of inhibitor compounds. These workers have found that combinations of sulphonamide and urea possessed bacteriostatic activity in the presence of the sulphonamide inhibitor compound *p*-aminobenzoic acid, when neither sulphanilamide nor urea by itself showed any effect on bacterial growth.

At the same time I am gratified to note that Mirick[2] has been able to advance further fairly conclusive evidence for the opinions I formed during my studies on inhibitor compounds[3]—which led to the introduction in Great Britain of sulphonamido-urea combinations—that the compound produced by sulphonamide-resistant strains of bacteria which was soluble in water, alcohol, ether and acids and inactivated by bromination, was actually *p*-aminobenzoic acid. At the time there was no chemical method available for identifying with absolute certainty the traces of *p*-aminobenzoic acid produced by these strains and distinguishing them safely from the other similar amino-acids produced by bacterial metabolism. Mirick has, however, by specifically adapting soil bacilli to destroy *p*-aminobenzoic acid, been able to inactivate specifically the inhibitor compound present in sulphonamide-fast pneumococci Type I. He has also been able to activate the *p*-aminobenzoic acid oxidases of these strains of soil bacteria by means of the natural inhibitor compound produced by the sulphonamide-fast Type I pneumococci. No further light has, however, been thrown on my observations that a 1 : 10,000 concentration of 8-methyl α-indole-β-aminopropionic acid in the culture medium of sulphonamide-fast streptococci increased the production of the inhibitor compound considerably, and that the production of the inhibitor compound was greatly retarded on media poor in tryptophane and organic –SH compounds. It seems extremely probable, therefore, that as it has been impossible to prove the presence of greatly increased quantities of *p*-aminobenzoic acid in the sulphonamide-fast organisms, this inhibitor is excreted rapidly by the sulphonamide-fast strains as a by-product of bacterial metabolism.

The sulphonamide-fast organisms I used to determine which compounds would inactivate the inhibitor substance were strains of *Streptococcus viridans* and *Staphylococcus aureus*. In order to determine the reaction of fairly primitive mesenchymal cells (for example, the histiocytes of the reticulo-endothelial system) and, in that way, to determine the formation of any toxic decomposition product, the sulphonamide-fast bacteria were implanted on to small squares on plasma clots in Carrel flasks, around which tissue cultures (chick periostial fibroblasts) were implanted. The percentage of deaths of the cultures was plotted against time. The sulphonamide-anti-inhibitor compounds were introduced into the same squares and also the organisms per c.c. of the suspension determined.

It was found that the main compounds that were active in sulphanilamide-fast organisms were sulphanilamido-urea, and to a lesser degree sulphanilamido-allantoin, while sulphanilyl-urate was inactive. These compounds also showed the curious phenomenon of increasing the rate of cell-growth and cell-migration of the fibroblasts towards them, even in the absence of bacterial infections, and were of lower toxicity towards the cells than any other of the sulphanilamides tested. In all the above experiments the strains of sulphanilamide-fast streptococci and staphylococci were very susceptible to sulphanilamido-urea, while they were unaffected by either sulphanilamide or by urea as such. The same applies to a slightly lesser degree to sulphanilyl-allantoin. Among other compounds that showed a high activity in these resistant strains were 7 : 7′-(tetrazo 4 : 4′-diamino-diphenyl-sulphone)-1-acetamino-8-naphthol-3.6-disulphonic acid and its sodium salt. This compound, however, to my knowledge, has not yet been tried clinically.

Preliminary clinical reports available from American workers on sulphonamido-urea show that the material offers great possibilities. It is also being claimed that sulphanilamido-urea shows a greater activity towards ordinary bacterial strains and that the toxic reactions that accompany all sulphanilamides are much less pronounced with this combination.

It is too early yet to judge the full significance of the anti-inhibitor compounds in sulphonamide therapy, especially in the treatment of war injuries ; but as the number of clinical cases caused by sulphonamide-fast bacteria is gradually and alarmingly increasing, it is becoming a matter of national importance to investigate as wide a range of sulphonamide-fast bacterial strains as possible, in order to determine as soon as possible the extent to which sulphanilamido-urea combinations will be effective in cases where sulphanilamide, sulphapyridine, sulphathiazole and sulphadiazine have been ineffective, partially or wholly, and whether it would prove practicable to introduce immediately for clinical routine anti-inhibitor-radicals into standard sulphonamide drugs.

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Proc. Soc. Exp. Biol. Med., **51**, 247 (1942).

Amer. J. Clin. Invest., **21**, 628 (1942).

Proc. Roy. Soc. Med., **34**, 349 (1941). *Lond. Hosp. Gaz.*, Clin. Supp., 5 (1940).

Amoeba lescherae

WE have already given a preliminary account of a new amœba which we called *Amœba lescheri*[1]. In a subsequent communication[2] we pointed out that, contrary to our first statement, the division of the nucleus was mitotic. Dr. Margaret Jepps has kindly informed us that, according to the rules of nomenclature[3], the specific name should be *lescheræ*, since the amœba was named to honour the memory of Mary Adela Lescher, the foundress of the College of Notre Dame in Glasgow. It is proposed to use this corrected form, *Amœba lescheræ*, in the full and corrected description of the morphology, cytology and life-history which will shortly appear in the *Quarterly Journal of Microscopical Science*.

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Dowanhill, Glasgow. April 24.

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[1] NATURE, **145**, 464 (1940).

[2] NATURE, **149**, 501 (1942).

[3] For example, Proc. IXth Internat. Congress, Zoology, Monaco. See Wenyon, "Protozoology", vol. 2, 1336 (1926).

Potatoes and War Economy

DR. COPISAROW[1] has done well to redirect attention at this season to the importance of our being able to produce 'additional' potatoes. Methods of propagation which he cites are the use of 'tops' (for the development of which Prof. Lysenko and his co-workers have recently been awarded the valuable Stalin Prize for Agriculture), of peelings, of 'eyes' (with a small amount of parent tuber attached), and my own preliminary tests with detached sprouts. All of these methods have given satisfactory or at least worthwhile yields, the first having, according to *Pravda* (October 7, 1942), enabled the Russians to increase their total area under potatoes by 100,000 ha. in 1942, in spite of huge losses in territory and materials ; the last method, and the possibilities of storage and vernalization of the detached sprouts, would seem especially worthy of detailed study in Great Britain as by it several effective propagules can readily be obtained from a single tuber without noticeable effect on this last even from a culinary aspect. Thus the self-same tubers can be used first for purposes of propagation and then for food.

In view of the vital importance of our main potato crop in war-time and of the significance attached by the two Ministries concerned to the planting of only imported tubers, many people will have been comforted by the recent announcement that far more 'seed' than a year ago has been brought south from Scotland ; others, however, are left wondering whether this is all properly certified material and, particularly, how much of it will be used to full advantage. For between the wide extremes of wastefully planting large tubers whole and of cutting them into hazardously small pieces there lies a happy mean which is both economical and practicable. The former of these extremes is all too common in England and follows the persistent selling of uncertified tubers of 'ware' size (in some recorded instances actually *averaging* more than 8 oz. each) for seed at exorbitant prices under the label 'Scotch Class 1'—a practice that, in the absence of proper advice about 'cutting', is to be condemned in war-time as wickedly wasteful of transport as well as of food or raw materials[2]. The other extreme is exemplified as implied above by the American 'potato-

'eye' trade and by the recent practice in Russia of saving and planting the top 10 per cent or less by weight of the larger tubers used in canteens, etc. My own experiments using potato tops and other cut pieces of various sizes and after various treatments indicate that, at least in the absence of favourable weather conditions on which we cannot count, or of laborious early planting in boxes[3], cut pieces of less than 20 gm. weight are unlikely to prove practicable in England except in conditions of extreme shortage of seed. But whether or not, under our very different climatic and present economic conditions, these Russian and American measures could be of commercial value in the British Isles, we should make haste to find out more about their practice and local application in case of emergency when their widespread employment might well save us a million tons of potatoes for food or other purposes.

Meanwhile the economical, practical mean for us lies in the widespread application of such less extreme cutting methods as have long been extensively employed in the United States. This cutting can be done on a large scale mechanically and *inter alia* made to solve our main problem in perfecting an efficient potato planting machine; it would save huge quantities of valuable carbohydrate material which is otherwise put back annually into the soil; it would abolish all need for the laborious and artificial separation of 'seed' from 'ware' tubers; it would help economize fuel and transport; it would speedily reduce 'degeneration', as small tubers tend to be more heavily infected with virus; and it would allow correspondingly better disease control, as more or all of our acreage could, with proper organization and education, be grown from certified stock using large as well as small tubers.

Contrary to popular conception and practice the tubers should be cut across transversely or into square-faced chunks rather than lengthwise—not only, with most strains and shapes of tuber, in order to expose less area to drying and subsequent fungal attack but also because morphologically speaking potato tubers are shoots and only by transverse cutting will the usual backward movement of growth-retarding substances from the dominant sprouts of the (physiological) tip be restricted and sturdy, productive daughter shoots obtained from the 'heel' (proximal) as well as the 'rose' (distal) end. Moreover, contrary to the usual directions given in Great Britain, the pieces if not planted immediately after cutting must be kept *moist* (for example, covered over with damp sacking) at least until they have healed by local deposition of suberin (12–24 hours at about 10° C. usually suffices). Everything considered, sets weighing an ounce or so and planted rather closer together than is usual with whole tubers may be expected to give the most satisfactory results.

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[1] NATURE, 151, 421 (1943).

[2] *Gard. Chron.*, 113, 36–7 (1943).

[3] *J. Min. Agriculture*, 50, 20 (1943).

Map Construction from Aerial Photographs

During the early part of the War a need arose for showing how a map can be constructed from aerial photographs. Since no suitable strips of aerial photographs were readily obtainable, strips of imitation aerial photographs were prepared by traversing a fairly large plaster relief model of part of a well-known part of the Western Highlands of Scotland with an ordinary camera kept at a small fixed distance from the base of the model, and maintained with its optical axis normal to the base of the model. The successive positions of the camera relative to the model were arranged so as to give adequate overlap of adjacent photographs and strips. Enlarged prints of a convenient size were made and successfully used for demonstrating the construction of a map from a series of strips of aerial photographs. (It should be noted that the camera had no collimating marks, and therefore the principal point of the photographs was assumed to be at the intersection of the diagonals. No special photographic materials were employed.)

Increasing numbers of people are taking a keen interest in the applications of aerial photographs, and a recent book[1] suggests various exercises. Under war conditions it is not at all easy to obtain photographs which can be used for practising the manipulation of aerial photographs. Hence the above method of making imitation aerial photographs, a method which may possibly have been employed and described by others previously, may be of assistance to those who possess no suitable real aerial photographs.

There seems to be no reason why these imitation aerial photographs should not be used for practising the compilation of mosaics; and when a stereoscope and stereometer are available, contouring might be attempted, the contours being tied to spot-levels determined by means of a cathetometer. Tilted photographs can be made and photographs with short overlap in order to show the difficulties which arise in such cases. Finally, maps compiled from imitation aerial photographs can be checked by comparison with the model.

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[1] "Aerial Photographs: their Use and Interpretation", by A. J. Eardley (see NATURE, April 24, p. 459).

H. L. Callendar and the Theory of the Liquid State

In 1902, H. L. Callendar[1] suggested that the variation of specific heat of water with temperature could be explained by assuming that a volume of liquid in equilibrium with its vapour contained dissolved in it a number of molecules of its own vapour. The number of molecules assumed to be dissolved was such that, as a vapour, they would occupy the same volume as the liquid, so that the concentration of dissolved molecules in the liquid was the same as that of ordinary molecules in the vapour.

Since Callendar's time, developments in general physical theory have removed the difficulty which he found in accepting a variable specific heat. As a result of X-ray studies, the chemical idea of different 'hydrol' molecules has also been superseded. Nevertheless it is the object of this note to point out that, applied to liquids generally, Callendar's suggestion is precisely equivalent to a later concept which has proved acceptable and capable of useful development.

In 1936, Eyring[2] pointed out that the energy necessary to make a hole in a liquid just large enough to accommodate a single molecule is equal to the energy required to vaporize a molecule leaving no hole. He showed that to a first approximation the entropy of such a hole in the liquid should be equal to the entropy of a molecule in the vapour, and moreover that the concentration of holes per unit volume of liquid should be equal to the concentration of molecules per unit volume of the vapour. With his collaborators, Eyring has since developed a useful account of the liquid state based on the concept of such holes.

It is very readily seen that the number, energy, entropy and effective size of the holes postulated by Eyring are identical with the number, energy, entropy and size of the dissolved molecules suggested by Callendar. Hence it would not appear justifiable to distinguish between the concepts. In fact, Eyring in his original paper uses the phrase "holes dissolved in liquids", while in the account of Eyring's work given by Fowler[3] the 'motion' of a hole is definitely interpreted as its being successively occupied by neighbouring molecules. Formally, a molecule which is moving into a hole position and forming another one behind it is equivalent to Callendar's "dissolved" molecule. Finally, Kirkwood[4] has proved he formal identity of the hole theory of condensation with the theory of critical solution phenomena.

The later work is, of course, much more elaborate and the concepts more developed, but it seems desirable hat Callendar's equivalent expression of the original dea should be recognized.

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Callendar, *Phil. Trans. Roy. Soc.*, A, 199, 147 (1902).

Eyring, *J. Chem. Phys.*, 4, 283 (1936).

Fowler, R. H., "Statistical Mechanics" (Cambridge University Press, 1936), 845.

Kirkwood, *J. Chem. Phys.*, 7, 908 (1939).

Science, Common Sense and Decency

In his strictures on Dr. Langmuir's opinions Mr. Bateman[1] affirms that it is "important to distinguish clearly between concept and reality". I agree. But has not Mr. Bateman confused the issue by his statement that the uncertainty principle "is a concept which has no bearing . . . on the *reality*, which is that at any moment a particle has both a definite position and a definite velocity, and that both are determined by its external and internal conditions". A little eflection will reveal that Mr. Bateman's "reality" he does not tell us the source of his inside knowledge n this realm) is in fact composed of at least four *oncepts*, namely, moment, particle, position and elocity. These objects are merely abstractions deved from our experience of the flux of events; we have no more reason to suppose that natural entities re ultimately composed of 'particles' than that they re bounded by 'lines'; and the status of 'moments' nd 'positions' is at least as old as Zeno. What meaning is to be attached to "the internal conditions" f a particle I frankly cannot imagine.

It is, as Mr. Bateman observes, significant that he "resurgence of metaphysics, spiritualism, etc. ither an ill-assorted pair, even apart from the 'etc.'] . has been mostly confined to physicists". But the reason for this is, I suggest, not that they cannot 'see' heir entities (has Mr. Bateman ever seen a gene?), but that their more refined modes of analysis—experimental and mathematical—have enabled them to penetrate into realms in which the 'common sense' concepts, such as 'particles', are no longer *adequate*. In some of its reactions an electron reveals itself as having the attribute of 'particularity'; in others it may be more appropriately described as a 'smudge'. It is 'really' both of these aspects, and probably much more. As Dr. Whitehead reminds us, "Undoubtedly molecules and electrons are abstractions. But then so is Cleopatra's Needle"[2].

I should be the last to argue that this 'resurgence' of interest in the problems of philosophy has always been productive of clear thinking, but it *is* significant that it is the physicists who have realized that, to quote Dr. Whitehead again, "Once you tamper with your basic concepts, philosophy is merely the marshalling of one main source of evidence, and cannot be neglected"[3].

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[1] Nature, 151, 450 (1943).

[2] "Concept of Nature", 171.

[3] "The Principle of Relativity", 6.

Mr. A. J. Bateman's comments[1] on Dr. I. Langmuir's ideas call in their turn for comment from the point of view of a physicist.

That eminent physicists are now proceeding to explore the philosophical bases of their science is a symptom of the fact that physics has now reached a stage when it is becoming possible to see its problems whole, and when certain metaphysical aspects are becoming insistent[2]. It is possible that many biologists, on the other hand, have not yet become aware of the limitations of the scientific method in its classical form.

Physicists fully appreciate the distinction between concept and reality[3], but realize that it does not follow that "as science progresses the gap between concept and reality decreases". It is at least theoretically possible that at any given moment our hypothetical 'world-picture' may be progressively diverging from the underlying reality. Mr. Bateman appears to regard the law of cause and effect as axiomatic, but this is an intuition on his part, and its acceptance is an act of faith, based on extrapolation from macroscopic phenomena. One would not feel justified in dogmatizing about the matter, but we cannot ignore the possibility that the uncertainties in our knowledge of atomic and quantum phenomena may be inherent in the phenomena themselves and not merely due to gaps in our own knowledge.

Presumably nobody would deny that mass effects are statistical integrations (though the meaning of "conflict between probabilities" escapes me), and that we can, for most purposes, ignore "individual idiosyncracies", but it is because we are now trying to account for these idiosyncracies that we must contemplate the possibility that traditional lines of thought may not, after all, be capable of accounting for them in detail.

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[1] Nature, 151, 450 (1943).

[2] Jeans, J., "Physics and Philosophy", Chap. 1 (Cambridge, 1942).

[3] Planck, M., "The Universe in the Light of Modern Physics", §1 (trans. Johnston, W. H., London, 1931).

IMPROVEMENT OF THE NITROGEN STATUS OF SOILS AND THE ORIGIN OF SOIL NITROGEN

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IN a communication in Nature[1] it was reported that farm-yard manure (cow dung), when added to soil, fixes the atmospheric nitrogen, and that the value of cow dung lies not only in its nitrogen content but also in its power to fix atmospheric nitrogen. Field trials have confirmed this observation. That nitrogen fixation or accumulation takes place on the addition of farm-yard manure even in the soil of temperate climates is evident from the following results obtained in the classical field trials at Rothamsted:

	Total nitrogen
1. Receiving no manure since 1843	0·095 per cent
2. Receiving farm-yard manure since 1852	0·256 ,,
3. Receiving complete artificials including ammonium sulphate	0·099 ,,

Moreover, we have shown[2] that molasses, different carbohydrates, glycerol, dextrin, cellulosic materials like paper, hay, leaves, fats like butter, *ghee* (clarified butter), salts of palmitic, oleic, stearic, citric, tartaric, malic, oxalic, acetic acids, etc., when mixed with soil or chemical surfaces like the oxides of zinc, aluminium, iron (Fe_2O_3), manganese, nickel, cobalt and copper, can fix atmospheric nitrogen both under sterile and unsterile conditions in presence of air. It has also been observed that the amount of nitrogen fixed per gram of carbon oxidized is much greater in light than in the dark, because light is actually utilized in nitrogen fixation.

Russell[3] has reported that the nitrogen content of grass land increased from 0·152 per cent in 1856 to 0·338 per cent in 1912. Similarly, a land permanently covered with vegetation for twenty-four years showed an increase from 0·108 to 0·145 per cent total nitrogen.

The foregoing observations clearly show that carbonaceous substances help in the accumulation of nitrogen and its fixation, and this explains why organic substances are valuable in steadying crop yield as observed in Rothamsted and other places.

Our experimental results show that the loss of nitrogen, chiefly due to nitrification, when ammonium sulphate is added to the soil is appreciably diminished by the addition of carbonaceous substances, which act as negative catalysts in the oxidation reactions involved in the process of nitrification, leading to a loss of nitrogen mainly in the gaseous state.

In most schemes of husbandry arrangements are made to keep up or even increase the supply of organic matter, while in forests the removal of leaves and other decomposable carbonaceous compounds is undesirable. Němec[4], studying the forests of Czechoslovakia, observed that the removal of the litter lowered the nitrogen content of the soil by 58·6 per cent.

Shutt's analysis of the Indian Head prairie soil, Saskatchewan, shows that after twenty-two years cultivation the percentage of total nitrogen dropped from 0·371 to 0·254. Here there was very little loss due to drainage, yet only a third of the lost nitrogen is recovered in the crop. Similar results have been reported with Minnesota and Kansas soils. Great tracts in the United States and in Canada, stable in their natural state, have been rendered liable to erosion by over-cultivation and fallowing and by grazing. Both on the cultivated and on the grazed land, the organic matter (carbonaceous substances) of the soil was rapidly destroyed by oxidation, causing a rapid loss of nitrogen as stated above. The effect has been an unprecedented destruction of the soil in recent years, not only by erosion but also by the loss of organic matter and total nitrogen due to rapid oxidation involved in the nitrification of proteins and other nitrogenous compounds.

In our recent experiments on nitrogen fixation the following results have been obtained[5]:

With numerous carbohydrates it has been found that even under completely sterile conditions the nitrogen fixed per gram of carbon oxidized in quartz vessels exposed to light with soil is 12·2 mgm., in glass vessels exposed to light it is 10·7 mgm., while in the dark it is approximately 4·5 mgm. per gram of carbon oxidized. The order of these fixations under sterile conditions is practically the same as obtained in unsterile soils. With the oxides mentioned above used as chemical surfaces instead of soil, and glucose as energy material, the nitrogen fixation per gram of carbon oxidized is of the order of 15–18 mgm. in light under completely sterile conditions, while in the dark it is 8–11 mgm. Under unsterile conditions the fixation in light varies from 30 to 46 mgm. and in the dark from 15 to 24 mgm. per gram of carbon oxidized. Moreover, recent experiments carried on with sterile and unsterile soils mixed with carbohydrates and other energy-providing materials show that the velocity of the oxidation of carbon in the carbonaceous compounds under completely sterile conditions is about a third to a half of that under unsterile conditions. It seems that nitrogen fixation can take place not only with the help of Azotobacter but also in the complete absence of bacteria, as a surface process aided by sunlight; and the chief source of nitrogen in soils in all countries is this type of fixation and not legumes as is believed to be the case in temperate climates.

This conclusion is partly corroborated by the following observation of Morse[6] with soils containing approximately 0·15 per cent total nitrogen. Analysis of soil from experimental plots of twelve years standing in Massachusetts showed no evidence of accumulation of nitrogen by the application of nitrogen fertilizers or by the growth of leguminous crops, nor did continuous production of non-legumes appea measurably to deplete the soil of nitrogen. Soi nitrogen varied irregularly from year to year, showing no special tendency to increase or decrease in any plot.

The higher value of the efficiency of nitrogen fixation obtained with oxide surfaces as compared with that obtained in soils is due to the fact tha the phenomena of nitrogen fixation and nitrogen-loss go on simultaneously; the fixation process is being opposed by the loss due to nitrification. Ammonium nitrite, which is unstable, is formed in the process of oxidation involved in the nitrification of the proteins and other nitrogenous compounds produced b fixation or originally present in the system (compar Dhar[7]). But in soils, there is already a certai amount of combined nitrogen—to the extent o 0·04–0·05 per cent in tropical soils—and hence the loss of nitrogen is more marked than when oxide surfaces are used containing no nitrogen. Apparentl therefore the efficiency of the process of nitroge fixation is much better in presence of oxide surfaces than in the soils containing nitrogen. These observations are of fundamental importance in explaining the evolution of fertile soils from the parent rocks. The geological deposits, that is, the parent materials of soil, do not contain organic matter, but can contain inorganic nitrogen in the form of nitrates or of ammonium salt in very small quantities. The nitrates can under the influence of light and moisture together with seeds form the first plant life or algæ, the nitrogen need of which s met from the inorganic nitrogen originally present n rocks in small quantities. The carbohydrates and cellulosic materials or other energy-producing materials formed in photosynthesis undergo decomposition in course of time and are oxidized, causing nitrogen fixation in this process, which is aided markedly by light absorption, and thus the store of nitrogen in the system is increased. This in its turn eads to a more abundant growth of vegetation, and he process goes on in which the carbon and nitrogen tatus of the system is improved, leading to the ormation of a fertile soil. This nitrogen fixation, which in the beginning at any rate is a non-biological urface reaction, is aided by light absorption, because ight is utilized in this process. As the original mineral s poor in nitrogenous compounds, the nitrogen fixaion is greatly enhanced in the beginning, but with he storing up of nitrogen the efficiency falls off and hus the nitrogen and carbon status of the soil eaches a maximum depending on the climate of the egion. As a matter of fact, much more nitrogen s fixed in soils in this manner by light absorption han the amounts fixed in all the industrial processes aken together.

The organic matter in the soil may also be caused y the growth of alga. It is believed to be valuable n most circumstances, but on newly formed soil it is f the greatest importance. The carbon of decaying lgæ is oxidized and the energy liberated leads to he fixation of atmospheric nitrogen.

The residual effect of cow manure as observed roughout the whole world may be due, not mainly o the conservation of nitrogen as hitherto believed, ut to the fixation of atmospheric nitrogen through he oxidation of energy-producing materials like entosans, celluloses, fats, etc., and aided by the bsorption of sunlight. It seems that wherever a sidual effect of a nitrogenous manure has been bserved, for example, with molasses, hay or cow anure, it is chiefly due to nitrogen fixation in the il; possibly no residual effect would be observed ith a manure which is incapable of fixing atmospheric trogen, although it may contain carbon. It seems at so far no worker has reported that legumes ave as much residual effect as cow or farm-yard anure or molasses.

In Indian soils under cultivation, as well as in ose of other tropical countries, the total nitrogen much lower than in the soils of temperate countries. is is due to the fact that the prevailing high temrature and intensity of sunlight accelerates the idation of carbonaceous and nitrogenous comunds in tropical soils, thus entailing a loss of trogen caused by the nitrification of protein and her nitrogen compounds. But when the land is vered with grass or other vegetation, this oxidation n be retarded and the loss of nitrogen diminished, th the result that the nitrogen content can be raised. ith cultivation, however, the nitrogen-level again ls down to the normal. By the addition of organic atter or covering with grass, the nitrogen content is raised both due to the fixation of atmospheric nitrogen and to its conservation in soil.

There is, however, one advantage of the high intensity of light and heat falling on tropical soils. The available nitrogen, that is, the sum of ammoniacal and nitric nitrogen, is much greater in tropical soils than in temperate ones, because of the greater facility of the oxidation of organic and nitrogenous substances in the former. Thus while the available nitrogen in tropical soils is about 10–30 per cent of the total nitrogen (0·04–0·05 per cent), the amount of available nitrogen in temperate country soils is only 1–2 per cent of the total nitrogen (0·1–0·2 per cent) present in the soil. This explains why a better crop can be grown in unmanured fields in tropical countries than in the unmanured fields of temperate countries under comparable conditions. Assuming that an acre of normal soil 9 in. deep weighs 1,000 tons, the amount of total nitrogen in European soils will be about 2,250 lb. per acre, while in Indian soils it is approximately half, namely, 1,125 lb. per acre. But the amount of available nitrogen per acre in European soils may be only 22·5 lb. whereas in Indian soils it is about 112·5 lb. per acre. The concentration of the dissolved nitrate and ammonium salts in soil solutions in the tropics is greater than in temperate climates, and hence the absorption of these nitrogenous compounds by plant roots is much greater in a short time than in temperate climates. By adding molasses or easily oxidizable carbonaceous substances like cow dung, hay, etc., to the soil, the nitrogen content is improved by nitrogen fixation. Along with the improvement in the nitrogen content of the soil the available nitrogen also increases, thus making the soil more fertile. From our experiments with numerous molassed fields in Allahabad and elsewhere, we have observed that, a month or five weeks after the addition of molasses, not only is the total nitrogen content of the soil highest but also the nitric and ammoniacal content of the soil is the highest; and that is the time when a crop has to be sown in the field.

In temperate climates an attempt should be made to improve the available nitrogen content by breaking the soil and exposing it to light and air in the spring, summer or autumn when the sunlight is of high intensity. This will, no doubt, lead to an increase in the amount of ammonium salts and nitrate, but during the process of nitrification a certain amount of nitrogen may be lost in the gaseous state. But this loss may not affect appreciably the soil fertility because of the large amount of total nitrogen present in such soils. Loss due to the escape of free ammonia cannot be marked specially in temperate climate, in view of the fact that such soils have a tendency to be acidic. Instead of adding ammonium sulphate to soils in temperate countries to increase the available nitrogen, it may perhaps be less expensive, especially under the present conditions, to increase the ploughing and breaking up of the soil, making conditions more favourable for oxidation and nitrification and obtaining a better crop yield without making the soils more acidic, as happens on the addition of ammonium sulphate. In the case of soils in temperate climates which have deteriorated and gone out of cultivation, it seems certain that the remedy lies in the addition of cow manure (farm-yard manure) or other readily decomposable carbonaceous substance like molasses, hay, etc., rather than by the addition of legumes, which seem to have not much residual effect on soils. If a quick result is not expected, wasted or deteriorated land can be improved from the nitrogen point of view by covering it with vegetation or grass and leaving it undisturbed for a number of years. In this way the carbonaceous substances from the decaying vegetation are oxidized and assist in the fixation and conservation of soil nitrogen ; thus the nitrogen status is improved.

[1] Dhar and Mukerji, NATURE, 138, 1060 (1936).

[2] Dhar, presidential address to the National Academy of Sciences, December 1935 and January 1937.

[3] Russell, "Soil Conditions and Plant Growth" (1931), p. 362.

[4] Nemec, *Forstwiss. Cbl.*, 53, 49, 147 (1931).

[5] Dhar and Seshacharyulu, *Proc. Nat. Acad. Sci. India*, 11, 97 (1941).

[6] Morse, *Mass. Agric. Exp. Sta. Bull*, No. 33 (1936).

[7] Dhar, NATURE, 134, 572 (1934).

THE TENNESSEE VALLEY AUTHORITY

AN EXPERIMENT IN REGIONALISM

By K. S. LOMAX

IT was on May 18, 1933, that the Act of Congress setting up the Tennessee Valley Authority became law. Through lack of effective planning to meet the successive floods, through unscientific farming and consequent loss of rich top soil, depression and destruction had spread throughout the valley of the River Tennessee and its tributaries—an area almost as large as England, with abundant natural resources including iron ore, coal, oil, timber, chemicals, fertilizer constituents, ceramic and aluminium clays, pigments and abrasives. Little was done until Franklin D. Roosevelt was elected president in 1932, and he suggested to Congress legislation to create a Tennessee Valley Authority. In 1933 the system consisted only of the Wilson Dam and nitrate plant at Muscle Shoals which had been started to satisfy the need for nitrates in 1917 and had a capacity of 39,000 kw. Now in 1943 projects are under construction which will increase the capacity of the system to more than two million kw., provide flood control storage of 15 million acre-feet and a nine-foot navigational channel from the mouth of the Tennessee to its upper reaches at Knoxville, 650 miles away.

Flood control, navigation, and the production of cheap and plentiful electric power are not the only activities of the Tennessee Valley Authority. It is a unique experiment in regional development. Its subsidiary activities include the development of agriculture, soil conservation, the encouragement of animal husbandry, the re-forestation of denuded areas, the development of phosphate fertilizers, investigation of the mineral resources of the area, the development of native kaolins for use in high-grade pottery, the development of additional uses for electricity in agricultural processes, the encouragement of co-operatives for collecting, grading and marketing agricultural products, the encouragement of recreational areas, the improvement of housing, education, and public health throughout the area.

The history of the Tennessee Valley Authority, however, has not been without controversy. There were forty-one law suits in the first five years of its existence, two being taken to the Supreme Court, where the T.V.A. was upheld on all counts. It was established that utilities had no monopoly and the Government had the right to sell electric power fro flood control dams in competition with privat interests. Then in 1939 difficulties arose within th board of three which managed the Authority, th chairman accusing his two colleagues of moral an ethical lapses. The outcome was that Presiden Roosevelt dismissed the chairman and Congres ordered an investigation into the affairs of the T.V.A The majority report of this inquiry cleared th Authority of the charges against it and conclude that "The Authority should be regarded as a settle and established institution in the Valley. Its construction programme should be carried to completio so that money already invested may not be waste or inadequately supported by revenue. The agricultural, forestry, public health and other regiona development programmes of the Authority ar generally acknowledged to be beneficial to the regio and to the nation as a whole and should be continue The Authority has already demonstrated the valu of unified river control under public managemen It is on the way to full demonstration of the practicability of promotional rates for domestic electri service which may be adopted as well by privat utilities as under public ownership."

The T.V.A. experiment has been called "costly' It has been argued that it benefits a fraction of th country at the expense of the rest and that it introduces Government competition with private enterprise. It has been questioned whether a singl authority can deal adequately and efficiently wit such diverse objectives as navigation, flood contro power production and the many subsidiary activitie The bitterest animosity has been caused, howeve by the policy of using T.V.A. power as a "yardstick to determine "fair" prices for power privatel generated elsewhere.

On the other hand, the T.V.A. is a bold imaginati scheme of regional development. It indicates a ne approach to the problems of such an area, and i achievements have already been notable, not lea among these being the raising of the standard living throughout the Valley. There are obvio economies to be gained from a multi-purpose proje applied to such a large natural system, and there a great advantages in being able to transfer organization and equipment from one dam constructio project to another. Undoubtedly an importa factor in the ability to produce abundant power low cost is the fact that the Tennessee Vall Authority was started in a period of depression wh labour and materials were cheap.

One of the most significant factors in T.V. development and one which we, thinking in ter of post-war reconstruction and possible reform the structure of local government, will watch wi special interest is the technique of administratio There are many units of local government in t area—the Authority embraces, for example, sev States and one hundred countries—and while t T.V.A. is above them it does not supersede the The official relationships between the T.V.A. and t States, counties, districts, and municipalities of t area are many and varied, ranging from inform agreements to detailed legal contracts. There h been from the start a high degree of co-operati between the T.V.A. and both the local units of t area and also other Federal agencies, and it can said that an unusual degree of initiative on the p of local units and of citizen participation has be encouraged. The third annual report of the T.V puts it admirably: "The planning of the river's future is entrusted to the T.V.A. The planning of the valley's future must be the democratic labour of many agencies and individuals and final success is as much a matter of general initiative as of general consent. The T.V.A. has no power or desire to impose from above a comprehensive plan for the social and economic life of the Valley."

INSULATION OF HEATING SYSTEMS

A. C. PALLOT gave a Cantor Lecture to the Royal Society of Arts on "Thermal Insulation at Medium Temperature" on November 23; the lecture, which included many topics of current interest, has now been published[1].

In a bulletin on heat insulation issued by the Ministry of Fuel and Power, it was pointed out that "In the national drive for fuel economy there is probably no single factor, which is common to all industries using heat in its many diverse applications and can produce a greater saving in fuel, than efficient insulation. The reduction of heat loss by insulation is a practical means of achieving a substantial economy in fuel by using materials which are available and can generally be easily and quickly applied without interruption to operation or to process routine"[2]. Comparative neglect of insulation is apparent in many industrial, commercial, and domestic buildings. In some industrial premises taken over by the Government, all the calorifiers, pipes and connexions were devoid of lagging, long lengths of main steam piping were exposed to the weather and were completely bare, and the entire condensate was allowed to run to waste.

The temperature range 100–400° F. covers all normal heating, ventilation and hot-water supply systems, as well as many industrial steam installations, accounting for the use of 60 million tons of fuel yearly—a quarter of the total output of Great Britain. Even a small fractional saving of fuel by the use of insulation would mean a substantial economy in national resources. Many quantitative data given in the lecture show that a highly polished metal surface is quite a good insulator. A given thickness of insulation is more effective on a large pipe than on a small one. 'Insulation' with unsuitable materials may actually increase the heat loss from small-diameter pipes. The first layer of insulation is more effective than subsequent layers in spite of the fact that a greater volume of insulating material is needed for each successive concentric ring. Insulating materials in common use vary from crumpled aluminium foil, reducing radiation losses, to asbestos, magnesia, glass silk and slag wool, reducing losses by conduction. Even aluminium paint will save about half the normal radiation losses. Under ordinary conditions the domestic 25-gallon cylinder loses heat by radiation equivalent to about 5 lb. of fuel a day. Insulation of such a cylinder in constant use would save about half a ton of fuel per annum.

The physical factors affecting heat losses are simple compared with those involved in calculating the economic thickness of insulation. A calculation made of the thickness of a given insulator needed to save a definite percentage of the bare surface loss shows that the thickness diminishes as the temperature increases. This is contrary to ordinary practice, but the 10 per cent of heat still lost through the insulation increases rapidly with the working temperature and a thinner layer of insulation will allow this to pass. A calculation of the most economical thickness of insulation will have to take account of the annual cost of the heat produced and the interest and depreciation charges on the proposed insulation. Both internal and external temperatures will vary throughout the day as well as throughout the year. The cost of the heat lost will depend upon both the cost of fuel and upon boiler efficiency. Hours of operation per annum must be considered, for the loss of heat is continuous while the boiler is in use, but some plants work throughout the year whereas others work seasonally or intermittently. Among these factors the thermal conductivity is the simplest occurring in the calculations, examples of which are given. Special attention is given also to the use of emergency materials as substitutes for orthodox insulator which may be unobtainable in war-time.

In the second part of the lecture, dealing with the insulation of structures, it is pointed out that the modern tendency to build light structures may considerably increase the amount of fuel needed to keep their interiors at a comfortable temperature. Not only will thin walls and roofs allow easy transmission of heat but also, if the walls are at a lower surface temperature, a higher air temperature must be maintained inside. In a well-planned building the initial cost of insulation may be more than offset by the reduction in initial cost of a central heating system as well as by the subsequent reduced consumption of fuel. In addition to its thermal results, the insulation of buildings minimizes condensation, because of the higher surface temperatures. 'Pattern staining', due to the transfer of dust from the warmer to the colder areas of plaster, is reduced, and most thermal insulators are effective in absorbing sound. Furthermore, insulation of concrete roofs reduces expansion, which sometimes causes structural damage.

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[1] *J. Roy. Soc. Arts*, **91**, 122 (1943).

[2] *Mines Dept. Fuel Efficiency Bulletin*, No. 2 (1942).

PREPARATION OF TEACHERS IN HEALTH EDUCATION

IT will be a happy day when we have in Great Britain a booklet corresponding to "Opportunities for the Preparation of Teachers in Health Education", issued by the U.S. Office of Education (Bulletin 1942, No. 1). Written in the form of a survey of twenty Teachers Colleges, ranging from Massachusetts to California, this work presents a bird's-eye view of the training of U.S. teachers in this vital subject. It is clear that "health education" is conceived by the U.S. Office of Education as something very different from the traditional 'hygiene', and it is to be hoped that as a result of the deliberations of the Board of Education's McNair Committee on the Training of Teachers, a similar breadth of vision will permeate the training colleges of Great Britain.

Among the obstacles to the achievement of adequate health education courses in the United States are listed the slowness of administrators to recognize the need for them and the lack of well-prepared health instructors —two causes potent also on this side of the Atlantic. Every training college lecturer and administrator in Great Britain should study carefully these detailed descriptions of twenty courses, and none can fail to reap some benefit from their reading.

A fairly typical programme is that of the San Diego State College in California, which offers courses (some "Required", some "Elective") in the science of life, health and social adjustments, human physiology, physiology of exercise, safety education, general bacteriology, embryology, genetics, mental hygiene, physiology of reproduction, physiology of infancy and childhood, and man and his biological world. No doubt at San Diego as elsewhere, achievement falls short of ideal, but at least the ideal is a high one.

An appendix gives details of colleges and universities in the United States offering courses in health education during the summer session of 1941. No fewer than forty-six are listed—whereas in Great Britain educationists wishing to equip themselves in this field during the summer vacation will be very largely dependent upon courses arranged by bodies such as the Central Council for Health Education.

The U.S. Office of Education is by no means satisfied with the state of affairs shown by this investigation. "Far too many pseudo-health educators and semicultists hold positions of responsibility in the public schools to-day simply because school administrators have either been unwilling or unable to lend themselves to this problem of teacher preparation in health education"; and it is equally true in Great Britain that this "should be sufficient reason why in these stirring times every effort should be put forth to improve on the present situation".

FORTHCOMING EVENTS

Saturday, May 22

Nutrition Society (at London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on Nutrition in Infancy.

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 2.15 p.m.—Annual General Meeting.

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. G. Coumoulos: "The Greek Scientists—Traditions and Ties".

Monday, May 24

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. H. V. A. Briscoe: "Some New Properties of Inorganic Dusts" (Cantor Lectures, II).

Copernicus Quatercentenary Celebration Committee (at the Royal Institution, 21 Albemarle Street, London, W.1), at 3.30 p.m.—Meeting in honour of Nicolaus Copernicus. (Sir Henry Dale, P.R.S., will open the meeting, at which Prof. Stanisław Kot and Dr. H. Spencer Jones, F.R.S., will deliver addresses).

Tuesday, May 25

Royal College of Physicians (at Pall Mall East, London, S.W.1), at 2.45 p.m.—Air Commodore C. P. Symonds: "Flying Stress" (Croonian Lectures, 1).

Wednesday, May 26

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. John Gloag: "The Influence of Plastics on Design".

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. H. W. G. Hignett: "Welding Research and Development in the United States of America".

Thursday, May 27

Electrical Association for Women (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Annual General Meeting; at 3.30 p.m.—The Rt. Hon. Viscount Samuel: "An Electrified Future".

Royal College of Physicians (at Pall Mall East, London, S.W1.), at 2.45 p.m.—Air Commodore C. P. Symonds: "Flying Stress" (Croonian Lectures, 2).

Friday, May 28

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Miss L. Evelyn Cheesman: "The Island of New Guinea".

Saturday, May 29

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Capt. Helmer Dahl: "Norwegian Universities and Schools—Past, Present and Future".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Occupational Therapist to take charge of the School of Occupational Therapy—The Medical Superintendent, St. Andrew's Hospital, Northampton (May 28).

Assistant Lecturer in Chemistry—The Bursar and Acting Registrar, University College of North Wales, Bangor (May 29).

Lecturer in charge of the Biology Department—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (May 29).

Dietician (non-resident) to assist medical staff in dietary of in- and out-patients at West Middlesex County Hospital—Medical Superintendent 'R.2', West Middlesex County Hospital, Isleworth (May 29).

Lecturer in Mathematics—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 31).

Two Teachers to take either (1) Metalwork or (2) Science and Mathematics, in the Junior Technical and Day Continuation Schools—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby (May 31).

Woman Gardener (non-resident) to prepare students for Horticulture as a subject of the Teachers' Certificate—The Principal, The Training College, Hereford (May 31).

Chair of Electrical Engineering—The Secretary and Registrar, The University, Bristol (June 1).

Lecturer in Engineering Drawing, including the teaching of Workshop Practice and/or General Engineering Subjects, in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (June 2).

Teacher of Mathematics, and a Teacher of Engineering Drawing and Practical Geometry—The Principal, Technical College, Church Street, Barnsley (June 5).

Teacher for Mathematics and Mechanics in the Technical School—The Director of Education, City Hall, Norwich (June 5).

Advisory Officer in Plant Pathology (Plant Husbandry)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (June 5).

Demonstrator (man or woman) in the Physics Department in London—The Warden and Secretary. London (Royal Free Hospital) School of Medicine for Women, Reed Hall, Streatham Drive, Exeter. (June 15).

Director of the Transvaal Museum, Pretoria—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2 (June 26).

Lecturer in Animal Husbandry at the Imperial College of Tropical Agriculture in Trinidad—The Acting Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

Lecturer in Geography and Mathematics—The Principal, The Training College, Norwich.

A Senior Post under the Aeronautical Inspection Directorate (applicants should possess a degree in physics or recognized equivalent and have an extensive knowledge of non-metallic materials, with a specialized knowledge of the production of Paints and Allied Products; Rubbers—Natural and Synthetic; Aircraft Dopes; Plastics, Glues, Cements; or Aircraft Textiles)—Ministry of Labour and National Service (Ref. A.224), Alexandra House, Kingsway, London, W.C.2.

Horticultural Instructor for Boys' Intermediate Approved School—The Headmaster, St. Joseph's School, Nantwich, Cheshire.

General Secretary of the Institution of Production Engineers—Selection Committee of the Institution, 36 Portman Square, London, W.1.

Mechanical Superintendent for the Ceylon Government Irrigation Department—Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1662), Alexandra House, Kingsway, London, W.C.2.

Senior Assistant Drainage and Irrigation Engineer for the Government of Sierra Leone—Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. F.595), Alexandra House, Kingsway, London, W.C.2.

Chief Instrument Engineer (Ref. C.1420) and an Assistant Instrument Engineer (Ref. C.1663X) for work at Trinidad, British West Indies—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2.

Road Engineer for the Government of Kenya Public Works Department—Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. E.656), Alexandra House, Kingsway, London, W.C.2.

Demonstrator (male) in the Department of Biology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.C.2.

Teacher of Mathematics, Mechanics and Elementary Science, a Teacher of Engineering (Mechanical) Subjects qualified to take Workshop Practice, and a Teacher of Building Subjects—The Principal, Erith Technical College, Belvedere, Kent.

Assistant Master for Mathematics and Science, with Physical Training and Games, at the Atkinson Road Junior Technical School, Newcastle-upon-Tyne—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 2.

Lecturer in Science—The Principal, Hockerill College, Bishop's Stortford.

Laboratory Assistant for work in Biochemistry Department—The Secretary, London Hospital Medical College, Turner Street, London, E.1.

Assistant Cultivation Officers—The Executive Officer, Cumberland War Agricultural Executive Committee, 6 Brunswick Street Carlisle.

Chief Industrial Planning Officer under the Government of India for Surgical Instrument Production—The Ministry of Labour and National Service, Central (Technical and Scientific Register (Ref. C.1644), Alexandra House, Kingsway, London, W.C.2

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SCIENCE AND THE PRESS

THE Conference on Science and the Citizen which was arranged last March by the Division for the Social and International Relations of Science of the British Association (NATURE, April 3, p. 382) was, as Mr. J. G. Crowther observed, the first in Great Britain to be devoted entirely to the consideration of the means which can be used to increase the public understanding and appreciation of science and the methods of improving them. The Press can exert a most powerful influence in this matter, and appropriately a whole session of the Conference was devoted to a discussion on science and the Press. Unless effective relations can be established in that field, the general appreciation, not only of the powers but also of the limitations of scientific research, which Sir John Anderson stressed as vital for the effective contribution of organized Government research, industrial research organizations and academic and private research institutions to the solution of post-war problems, can scarcely be achieved.

The subject was frankly and fully discussed at the Conference. It was recognized that as regards the human element there have been faults on both sides. While it would be unfair to expect the scientific community to accept the whole responsibility for the failure of science to exert upon the public mind the influence that it should, scientific workers appear much more disposed than formerly to admit their own shortcomings in the task of dispelling public ignorance of science. It is recognized that the task of exposition is vital and that it calls for qualities of mind no less deserving of respect and reward than those of the investigator whose results in some recondite but important field have to be interpreted to the lay mind.

We may leave on one side the admitted weakness of many scientific workers in interpreting their own results, their tendency to keep to themselves, their shyness and technical jargon—these are matters which will undoubtedly be corrected from within, partly as the effect of a wider and more cultural education as a basis for scientific study is felt, partly through the efforts made by scientific men themselves to counteract the effects of excessive specialization now that the danger is recognized, and partly by the pressure of professional opinion awakened to the importance of closer and fuller contact with the world at large if men of science are to play a fitting part in its shaping. What we may fairly look for as one result of the Conference is a more generous attitude to the scientific expositor himself, for he has rarely received from his confreres the honour that is his due. Nevertheless, as Mr. J. G. Crowther pointed out, until it is possible to make a reasonable income from reporting science, very few good men are likely to become what the Americans call 'science writers'. However, it is at least as important that such expositors should be sure of the appreciation and support of their professional colleagues in the world of science.

The ultimate factor on the personal side of this question is the long-range one of education. The difficulties arise as much from the neglect of cultural and human elements in the training of the man of science himself, and from specialization at an over-early age making him a half-educated man, as from the failure to include in the education of every citizen such a broad training in the method and outlook of science as will fit him or her to live intelligently in a world in which scientific factors have so profound an influence. They will not disappear entirely until these educational defects have been rectified and come to fruition in the following generation, and this factor must be kept in mind in considering what form of organization should be adopted to improve the immediate position and to serve the needs of adult education in this respect.

There can be no question that, as Mr. H. Brewer has pointed out in a recent letter (NATURE, May 8, p. 534), a large measure of responsibility for the present position lies on the shoulders of scientific workers themselves through their neglect of organization to that end. The work which Science Service has been doing in the United States since 1921 has no parallel in Great Britain, and the Institution for the Popularization of Science which now conducts Science Service is even further ahead. It is not sufficient to blame the Press for its failure to appoint science editors or scientific correspondents, when on the side of the scientific worker arrangements for the presentation or interpretation of scientific and technical advance are so defective and poorly organized. The neglect of scientific workers to organize on rational lines their own publications within the fields of a particular science even in these days of paper shortage is a further illustration of this failure.

One of the most significant features in the present situation is the great opportunity which the War has opened up for the wider presentation of scientific and technical knowledge to the many who, in the Forces or in their war-work, have become engaged in scientific and technical operations. Mr. Crowther did well to remind us of the field that is here open for increasing the efficiency of war production, and his suggestion that the Minister of Production should, like the Ministers of Food and Fuel, secure space in the daily Press and run a series of scientific and technical articles on the innumerable fascinating non-secret processes used in the field of production deserves to be explored. To assist the worker to understand what he is doing is a sound method of improving production or maintaining it under stress, and is a prime reason for greater attention to science in the Press. It is equally important that there should be a widespread appreciation of the implications of scientific advance in such fields as nutrition, health, agriculture, fuel, the use of the land, forestry, and the like, so that reconstruction may be formulated and judged on impartial and practical lines. That is a further urgent reason for attention to this question; the problem of the social relations of science, with its claims for wider and fuller consideration, is an additional reason.

Mr. Henry Martin, of the Press Association, in his paper at the Conference, urged with some force that it is for science to take the first step towards a *rapprochement* with the Press, and he referred to the encouraging results which have already attended some early steps in this field. There was immediate response to the articles issued on behalf of the Central Council for Health Education, and to the work of the British Council. The Press conferences held during the War at regular intervals by the chief medical officer of the Ministry of Health are a further instance of wise co-operation with the Press, and Mr. Martin spoke with warm approval of the Press Bureau of the Ministry of Information. What science needs, he suggested, is a Press Bureau for the collection, collation and dissemination of scientific information, with offices in or near Fleet Street. Such a bureau should have international ramifications and contacts in the foreign capitals so as to permit of interchange of information and rapid and frequent consultation. Each bureau would, as in London, be responsible for organizing the collection of science news in its own territory.

Such a Bureau would require a director, together with an editor or a news editor and a small staff of men with both journalistic and scientific qualifications—men with a practical knowledge of newspaper needs and technique, and with a catholic interest in, and knowledge of, science, combined with a capacity for assimilating material in the raw and turning it into simple language for publication in the daily Press. Such a combination of qualities is by no means easy to find, and the question of personnel is likely to be a real difficulty in launching any such scheme. Mr. Martin is right none the less to stress the importance of such qualifications, and particularly in the selection of the director, who besides being well known to, and *persona grata* with, scientific men must possess first-class organizing ability.

The brief sketch of the activities of the director and of the Bureau which Mr. Martin outlined show how much might be done, not only to put the relations of science and the Press on a firm footing o understanding and mutual confidence, but also to open up an even richer field than at present in the magazines and periodicals. An essentially similar scheme was outlined by Mr. Ritchie Calder in hi plea for an Institute of Scientific Information. H recalled that, at its Dundee meeting in Septembe 1939, the council of the British Association had on its agenda the discussion of a scheme for the establishment of an organization in Great Britain linked up with similar agencies in Europe and the Unite States to ensure a regular, accurate and up-to-dat service of news for the Press, films and radio, o scientific developments.

Mr. Calder did not go into the same detail as Mr Martin in his proposals, but he stressed, like him the importance of very careful selection of staff an of establishing links with panels of experts in a branches of science. Upon such personal relation and contacts the success of any such Institute o Bureau must very largely depend, and it is the mor important therefore that Mr. Martin's advice to pro ceed slowly should be heeded. Time will be require for the discovery of staff and for the establishmen of the essential relations and organization, which it self may be a matter for experiment, just as th technique of communication itself merits research, as Mr. Crowther pointed out.

What must be recognized is that these tasks cannot be left to the casual observation or investigation of busy men who are primarily engaged on other work. Exposition and interpretation must be a full-time primary occupation with appropriate status and financial recognition. Furthermore, it is essential that the organization of any form of Press bureau for science should not be undertaken without consideration of scientific and technical publications as a whole.

Granted the wider interest that the War has awakened in science, it may well be held that both Mr. Calder and Mr. Martin are unduly optimistic as to the effect of the War on the mental attitude of the average reader. There is at least this much in Mr. Wells's view that the practicability of using the newspaper to-day as a vehicle of instruction may be open to challenge. Admittedly it is difficult to view some newspapers as other than purveyors of amusement and sensation, but that is not true of all. Are we even to assume that the popular newspaper must always be limited by the deficiencies in ideas and education of the readers for whom it caters, and to exclude the possibility of even any slow advance in this respect?

To adopt that position seems uncomfortably like an admission that the War will be fought in vain, and no world order established worthy of the effort and sacrifice made. Short of such a defeatist attitude, we must utilize the Press as one means of consistent interpretation and exposition to the public of at least the social significance of scientific and technical advances as they are made. We should neglect no means by which the task of making every citizen aware of the place of science in the modern world may be discharged more effectively.

The charge of complacency is easily levelled against both the scientific worker and against the Press. What is required is constructive criticism, goodwill and readiness to co-operate. In this matter of publication, scientific workers have clearly to set their own house in order, and one result of closer attention to that would be more first-class exposition in text-books and articles in the magazines and periodicals, the elimination of useless jargon and of the grosser overlapping of publication, particularly of abstracting.

It may well be hoped that the Conference will stimulate further consideration of the problem by the professional associations of scientific workers and of journalists themselves. The hope of progress lies largely in the collaboration of such professional bodies on both sides. Some of the opportunities were clearly displayed at the Conference—opportunities which it requires no fresh organization to seize. Organization may enlarge those opportunities, but no new technique will be needed: it can be done only by trained minds devoted as implicitly and sincerely to the exposition of the results of scientific discovery and their application as those devoted to the acquisition of fresh facts and discoveries.

To repeat what was written in these columns many years ago: "The imagination of mankind will only be fully touched by the achievements of science and man roused to a wider application of scientific method, when innumerable artists of science, great and small, in utter fidelity to truth—to science as to life—have made plain its mysteries in words understood of all". That task rests finally on the shoulders of the expositor. Deriving his authority from his power of comprehending his subject, assessing values, and understanding his public, his scientific training must be supplemented by his ability to interpret facts and values in language understood by the common people. In proportion as he displays the same qualities of mind and unswerving loyalty to truth which his fellow men of science show in the laboratory investigations, the task of exposition will stand out before all in its true greatness, as compared with that of propaganda with which it is too often confounded.

AUTHORITARIANISM VERSUS INDIVIDUALITY

The Fear of Freedom

By Dr. Erich Fromm. (International Library of Sociology and Social Reconstruction.) Pp. xi+257. (London: Kegan Paul and Co., Ltd., 1942.) 15*s.* net.

THAT our world stands in flames and that no one can say with any hope of finality what in fact is happening to us are facts which are present in everyone's mind. Most of the attempts to explain the situation from recent economic and sociological causes are patently insufficient, and Dr. Fromm is wise enough to present his excellent survey with a clear eye on its necessary limitations. His analysis of the individualistic character-structure of modern man, shown in relief against the contained collectivity of the Middle Ages, is an excellent example of the value of the historical method to psychological understanding. The fundamental premises of the Gothic mind were self-evident and unquestioned. Men marched in step with their time. Their fate was laid down and contained in their community. From the Reformation onward this containing envelope was ruptured and the individual began to emerge into a world which no longer shielded him from the deep-rooted sense of his own impotence and powerlessness over and against dangers and forces he could not control. Instead of being integrated and enclosed he felt exposed and alone, and this was projected into the idea of a hostile deity whose arbitrary nature demanded indefinite and intense placatory effort. The Calvinistic conception of God and the world were the inevitable result of this ejection of medieval man from his contained paradise.

Dr. Fromm has excluded the study of myths from his field. It is a pity. Because the evolution of conscious man from the instinctual paradise of Nature, in which primordial unconsciousness enclosed him in a timeless garden, is surely the continuous archetype of every new step towards individual consciousness. But when we ask ourselves what is that force which time and again in history has prised man away from his containing background, and driven him forward upon this age-long experiment of individuation, can we, in fact, answer it in the terms given by the title of this book? Is it, in fact, the fear of freedom which is at bottom responsible for the authoritarian character-structure of the neurotic modern man? If we take the whole evolutionary story, we observe the fact that before he begins his ascent primitive man can only integrate his psyche outside himself in his tribal container. The moral principle operates not within the individual soul but through tribal law and taboo, and the amazing complexity of primitive systems of kinship manifest the compelling force of social integration. The social man, therefore, precedes the individual man. He is the evolutionary plinth upon which individuality eventually must stand.

From our experience of individual development we know that at every fresh stage in consciousness there is a tendency to recoil or regress back to an earlier condition. Evolution is never a constant forward movement. The stepping backwards into the security of the past is like the pull of psychical inertia, in opposition to which individual consciousness eventually declares itself. The totalitarian mentality of the present time shows all the characters of just such a regressive movement to an archaic pre-Christian model. On the other hand, as Dr. Fromm clearly sees, the individualistic trend of post-Reformation psychology can be leading only to a new conception of individuality, in other words to man in the fullest expression of his whole nature. But just because the author conceives this individual experiment in terms of freedom, he gives to man's capacity for free and spontaneous expression the whole meaning of deliverance. As he has left it, the problem of individuation is simply a matter of developing the capacity to be oneself in place of the artificial personality which is a more or less mechanical response to collective assumptions and expectations.

Everyone can agree that this problem of the original spontaneous human being versus the authoritarian civilized artefact is the main issue of our time. But what Dr. Fromm has omitted from his survey is the undeniable fact that the self-discipline required to bring about an order of freedom within is not to be attained by the mere cultivation of spontaneity. The way of individuation is no new experiment. Various methods of spiritual development have, in fact, been practised in the West as well as in the East. But the goal of wholeness or completeness has never yet been attained without a religious devotion and rigorous self-discipline. Surely the reason why the authoritarian hypothesis is so readily accepted by mankind in general is simply because the way of individuation is infinitely more exacting and difficult. To be completely oneself in the sense of living one's life with absolute security and integrity is indeed the heroic path. This freedom is realizable only on a higher level of responsibility.

It would seem, therefore, that no one is capable of developing his fullest gifts and powers unless he knows in his heart that his creative task is acceptable to the God he serves. Only when a man feels that the fullest expression of individual life and consciousness lies near the heart of God's purpose can he give his complete devotion to it and submit to the discipline it involves. For individuation also involves the social task as an integral aspect of being. In his historical chapters Dr. Fromm has emphasized the fact that the authoritarian conception of God must be related to man's sense of insecurity and helplessness, and that this authoritarian character will inevitably persist so long as men project absolute value into some external condition, as for example, the State, the Mikado or even an absolute Deity. If this hypothesis is correct, that the regressive authoritarian mentality is invariably dependent upon some non-human absolute, it would surely follow that man can achieve wholeness only by accepting an evolutionary relativity both in his conception of God and of the ideals by which he navigates his own life. But to omit these ultimate issues altogether as outside the scientific field is surely to ignore the very centre around which a total integration is even conceivable.

Although the work suffers from this serious omission, the author's analytical conclusions seem to me incontrovertible and of considerable importance. It is a genuine contribution, particularly in regard to the right understanding of the sociological factors which operate so powerfully in human psychology.

H. G. Baynes.

PROBLEMS OF GEOMORPHOLOGY

Geomorphology

Systematic and Regional. By Prof. O. D. von Engeln. Pp. xxii+655. (New York: The Macmillan Company, 1942.) 4.50 dollars.

THE recent revival of interest in geomorphology is reflected in the appearance of a number of text-books in the past five years. The most recent, by the professor of geology at Cornell University, is to be welcomed particularly because it is intended for more advanced students. The author assumes that the reader has already completed an elementary course of geology, and that he is acquainted with the nature and operation of geological processes. By omitting much of this introductory matter, Prof. von Engeln has been able to devote much more than the customary space to the discussion of wider concepts.

Short chapters are devoted to 'first order relief (the forms of the earth as a whole, of the ocean basins and of the continents), the relief of the ocean bottoms (graphically illustrated by some simple diagrams) and geomorphic units. Much of the rest of the volume deals with the relief of the continents, and the treatment given is unusual and stimulating. Like most American geomorphologists, Prof. von Engeln believes that the terminology and concepts of W. M. Davis afford a most convenient basis for the description and discussion of many relief features but he is not content to ignore other approaches to the problem, and devotes considerable space to consideration of the views of Walther Penck.

The teaching of W. M. Davis gave great prominence to the concept of the 'cycle of erosion'. He emphasized the fact that many landscapes can be regarded as having been developed by the dissection of an uplifted region, the stages of dissection being those of youth, maturity and old age. He held that long continued erosion would lead to reduction in altitude and to the formation of a low-lying plain, a peneplain. In the frequent re-statement of these views perhaps an undue emphasis in some cases has been laid on the comparative rapidity of the uplift which initiates the cycle, and on the long-continued stability of the land during its degradation. The recognition of erosion surfaces is held to be of primary importance in the interpretation of topography: as Prof. von Engeln points out, "the uplifted, more or less dissected, peneplain surface is a marker of the same kind, but of even greater significance, to the geomorphologist that the stratification plane is to the stratigrapher".

The concept of the 'geomorphic cycle' has been criticized, particularly on account of the long-continued stability necessary to permit of the complete peneplanation of a large area, but it has afforded a framework for much fruitful discussion of relief. It is therefore particularly fitting that Prof. von Engeln should devote an early chapter to a very interesting discussion of the peneplain concept. In this and a later chapter he considers the views of Penck in some detail: Chapter 13 (the Walther Penck geomorphic system) probably gives the fullest summary of Penck's opinions which has appeared in English. Penck believed that the Davis cycle of erosion applies only in the special case of rapid uplift followed by prolonged *stillstand*, and that varying rates of uplift are of primary significance in the development of types of relief. In particular, he considered that in certain cases very slow upheaval controlled the development of land forms; for example, in a newly emerged land rising very slowly and continuously he suggested that degradation would level the area as rapidly as it rose, so that there would be no increase in the amount of relief. Such a featureless plain or *primärrumpf* would truncate structures, and would have many of the characteristics ascribed to a peneplain as defined by Davis, but it would not have resulted from the degradation of a previously elevated tract. Such a *primärrumpf* might be raised later by an acceleration in the rate of uplift. Probably a great variety of land forms would result from differences in the ratio of rate of uplift to degradation.

In the present volume it is not suggested that the ideas of Davis and Penck are mutually exclusive. It is clear that both lines of approach are legitimate and may be useful. The two systems differ in the interpretations of slope forms, and if the attention here paid to Penck's views leads to a closer study of slopes and their development it will have been amply justified.

On the whole, the conclusions of British geomorphologists have been in line with Davis's concept of the cycle of erosion, and intermittent uplift with successive periods of comparative *stillstand* has been held to explain the origin of the features observed. In general, these views have been supported by much recent work on the gradient curve of rivers; Prof. von Engeln makes little comment on this method of investigation. In Britain there is much opportunity for such detailed studies, but it is not surprising that many American workers are more attracted to wider problems.

There is an interesting chapter on factors of rock strength, while later chapters deal with the history of the folded Appalachians, desert and glacial geomorphic cycles, coasts, coral shore lines, karst topography and land forms resulting from volcanicity. It is no criticism of a work such as this to suggest that many workers will find statements with which they may not wholly agree. For example, the usual definition of superimposed drainage would scarcely cover the case illustrated in Fig. 114; the diagram showing Willis's interpretation of rift valley structure (Fig. 227) also is misleading owing to the geological shading adopted.

It remains only to add that the volume is illustrated in the lavish manner to which we have become accustomed in American works of this type, and that a wide range of references to classical and current literature is given. By supplying such a thoughtful account of many aspects of geomorphology the author has placed teachers of geology and geography in his debt. It is a volume which may be warmly recommended for the reading of more advanced students.

A. E. TRUEMAN.

THE POLYNESIANS

Polynesians—Explorers of the Pacific

By J. E. Weckler, Jr. (War Background Studies, No. 6: Publication 3701.) Pp. iv+77+20 plates. (Washington, D.C.: Smithsonian Institution, 1943.)

THE exploits of the early Polynesians in discovering and populating, at one time or another, every habitable island in the Pacific mark them as the most daring deep-sea voyagers the world has ever known. In spite of having tools made of stone or shell only, they fashioned large double-keeled ships which they stocked, like arks, with food-plants and animals, and then transported themselves and their women into the unknown. True, there are islands at intervals along the route which they almost certainly took from the eastern end of Asia to the nearer islands of Polynesia, but even these voyages entailed a week or two at sea, while islands like Hawaii and New Zealand took longer to reach. There is some controversy as to whether these emigrants travelled through Micronesia or Melanesia, the inhabitants of both showing certain cultural affinities with the Polynesians, but the author considers that evidence points rather to the northern route, with what one might call a backwash to the marginal islands of Melanesia from Samoa.

After discussing his reasons for assuming the Micronesian route, the author describes the ships used by the ancient Polynesians as compared with their present-day canoes, and again emphasizes their skill and courage in facing the unknown. Their navigation was aided by a knowledge of the stars and an extensive study of the weather, in the forecasting of which they were, and still are, adepts. The colonizing of the new lands presented increasing difficulties as they forged farther afield, for not only was the terrain different, coral atolls replacing the fertile volcanic islands, but also the supplies of food plants they brought with them must have been running short and there was no food for their animals. Colonization in these circumstances was no mean task, and although they eventually reached the more fertile lands of Polynesia proper, they might not have been able to profit much at first from them owing to the lack of plant and animal stock. Whatever their route or methods, however, the fact stands out that these intrepid people established themselves throughout the Pacific islands as far even as Easter Island. It is also possible that they reached South America, while their own traditions indicate that they penetrated into the Antarctic.

Following this introduction, the author treats of Polynesian ways of life first in pre-European times and then in the difficult transition days of early contact with their conflicting cultures, and finally in the present day. In a short appendix there is a brief account of each of the principal island groups, and the paper is illustrated by a map and excellent photographs, and accompanied by a bibliography.

K. RISHBETH.

Fuel Testing

Laboratory Methods in Fuel Technology. By Dr. Godfrey W. Himus. Second edition. Pp. xvi+288. (London: Leonard Hill, Ltd., 1942.) 21*s*.

INDUSTRY in general has not given adequate attention in the past to thrift in the use of fuel. In Great Britain coal has been abundant, good and relatively cheap. Fuel has usually been a minor item in cost of production. War conditions have brought a change measured by the scarcity and cost of fuel. Moreover, it is unlikely that pre-war conditions will ever return. Present conditions have caught many with plant inadequate to handle lower-grade fuels and operated by staffs lacking in technical knowledge to cope with new difficulties. One result has been the issue by the Ministry of Fuel and Power of much literature in pamphlet form full of practical advice on most of the problems facing the operational staffs of fuel consumers. Last year the British Standards Institution issued two new specifications on (*a*) "The Sampling of Coal and Coke", No. 1017, 1942, and (*b*) "The Analysis and Testing of Coal and Coke", No. 1016, 1942. These collect and codify what has previously been scattered in several specifications, representing the combined experience of many years. They give the general impression of an increase in the elaboration and refinement which is necessary in research and critical work. Anyone familiar with the conditions under which coal is bought, sampled and handled in ordinary industrial practice will doubt whether all this refinement is necessary. The book by G. W. Himus is a timely production, for not only does it incorporate the essentials of the British Standards Institution specifications, but also it goes much further, with chapters on liquid and gaseous fuels, technical pyrometry and other matters of interest to the fuel technologist. It is the most recent and comprehensive work of its kind available to those chemists and engineers who are compelled by circumstance to interest themselves in industrial fuel economy, and of these to-day there are many.

H. J. H.

How Aeroplanes Fly

By W. O. Manning. (Oxford Air Training Manuals.) Pp. 64. (London: Oxford University Press, 1942.) 2*s*. net.

THIS volume is yet another added to the spate of publications dealing with the several branches of aeronautical sciences from the semi-popular outlook. It is not easy to see exactly what type of reader the author envisaged when writing this. It is not the ordinary popular descriptive book, as it does not link up with aircraft by giving photographs of appropriate machines, but on the other hand its technical aspect is so elementary that it can scarcely appeal to anyone with any pretence to the elements of aeronautical knowledge.

The text is well written, very lucid, and largely free from those inaccuracies that many authors commit when endeavouring to present an abstruse subject in simple language. It presents the theory of flight in chapters on the atmosphere, sustenation of the wings, control and stability of the aircraft, propulsion by the airscrew, choice of engines, and types of aircraft for different purposes. There are a few cases where attempts at simplification have resulted in a statement that seems unnecessarily vague for a scientific work. For example, it is stated that in certain engines the water jacket is "no thicker than a piece of tin". How thick is a piece of tin? Anyhow, the material to which the author is apparently referring is tinned sheet steel. Also the word "fuselage" is used constantly instead of "body". This practice was officially discouraged some time ago, and the more general word "body" is always used in Air Ministry correspondence to-day. The author surely sometimes underestimates the intelligence of his reader when he says that "60 miles an hour is 88 feet per second", and goes on to add that "30 miles an hour is 44 feet per second".

Altogether this is a pleasant, readable book for a beginner who will necessarily not read it too critically.

Steels for the User

By R. T. Rolfe. Second edition, revised and enlarged. Pp. xi+356+42 plates. (London: Chapman and Hall, Ltd., 1942.) 25*s*. net.

THAT this book has been found of practical value by users of steel is shown by the fact of a second edition being called for after three years. The author is particularly concerned with plain carbon steels; and although alloy steels are discussed when necessary, he is at pains to show that by suitable heat treatment the simple carbon steels may be given a wider range of usefulness than is sometimes supposed. The value of the book is essentially practical, and many examples of applications in service, and also of service failures, are discussed in detail. Some of the minor applications of steel which have a metallurgical interest of their own, such as needles and instrument pivots, usually neglected in text-books, are included.

The new edition contains much new matter, especially on heat treatment, welds, and fatigue testing. The short theoretical section is less satisfactory, the iron-carbon diagram on p. 35 being quite out of date, but this is not likely to mislead the user for whom the work is intended, and whose requirements are not met by the standard text-books. The presentation throughout is clear, and the numerous illustrations are representative and well reproduced.

Bibliography of the Literature relating to Constitutional Diagrams of Alloys

Compiled by Dr. J. L. Haughton. (Monograph and Report Series, No. 2.) Pp. iv+163. (London: Institute of Metals, 1942.) 3*s*. 6*d*.

THIS compilation gives, in systematic order references to papers dealing with the constitution of metallic alloy systems. It does not include physical properties unless they have been used as a means of determining constitution. It represents the result of many years of careful card-indexing and should save investigators a great deal of trouble in searching the literature. The first 125 pages cover the binary systems, but another 34 pages are needed for the ternary alloys, a larger number than might perhaps have been expected. More complex systems have been very little investigated. The book is published at a low price by the Institute of Metals and the author has in most instances added the page of the abstract to be found in the *Journal* of the Institute, for the convenience of readers who have it at hand. Besides metallurgists, chemists interested in phase equilibria will find the publication of value

ORGANIZATION OF AMERICAN SCIENTISTS FOR THE WAR*

By DR. KARL T. COMPTON
President of the Massachusetts Institute of Technology

IN America we have two principal scientific societies which are broadly representative of all the fields of science and which are rather parallel to the Royal Society of London and the British Association for the Advancement of Science. Dr. Frank B. Jewett, president of the National Academy of Sciences, has asked me to deliver his personal message to the president of the Royal Society of London, Sir Henry Dale, and in addition he requested me to express the admiration which is felt by the members of the National Academy of Sciences for the magnificent manner in which the scientific men of Great Britain have thrown the whole weight of their energies and abilities to master the innumerable technical problems arising in this War. He wanted me to assure you that in so far as we can do likewise, we in America are making a sincere effort to handle our similar problems and co-operatively to supplement the great work which you are doing.

Dr. Isaiah Bowman, who was elected president of the American Association for the Advancement of Science last month, also gave me a message of greeting to British men of science from which I quote as follows: "Now that the war has advanced to the stage at which we begin to talk of post-war plans, we feel more than ever the need for collaboration between Great Britain and the United States. While there is no such thing as an Anglo-American bloc in world politics, there is such a thing as close comradeship in the fight for principles. This comradeship we feel whenever we deal with the leaders of Britain and whatever the field of interest. I venture to predict that, whatever difficulties may arise, we shall find that comradeship and agreement upon principles will ever mark our future relations. This belief is based upon our widely recognized common responsibility for the peace and safety of mankind in the years after the War. If England is being changed by the War, the United States is changing just as rapidly. Once our President was able to report on 'the state of the Union', as our constitution provides, almost without touching on foreign affairs. Two world wars have changed both the tenor and the scope of such messages. The state of the Union now includes the state of the world. This conception of the state of the Union lays new obligations upon us all. The scientist can no longer report on the state of the sciences. He must report on the impact of science upon society. He must make use of the qualities of mind that science fosters in dealing rationally with the terrible waste in vital resources that war imposes upon the human species. We may hope that the day will soon come when every mature man and woman will feel himself responsible for the state of the Union and act responsibly in that sector of our common life committed to his care, no matter how small the sector may be, no matter how humble . . . no matter where one starts in estimating future problems and future responsibilities, one ends by recognizing the special bond between America and Britain, by acknowledging the rich inheritance that has been responsible for so many strong elements in American life, and by elevating the comradeship that we both feel and need."

Peace-time Organization of Scientific Men in the United States

The scientific and engineering work in the United States may be discussed under three categories: first, the agencies of the Federal Government, exclusive of the Armed Services; second, the agencies within the Armed Services; and third, the non-governmental agencies.

Federal Bureaux. The scientific services of the Federal Government in peace-time are spread through about forty federal bureaux, of which eighteen can be called primarily scientific. Their operations involve only about half of one per cent of the total peace-time Federal budget, but their work is, of course, absolutely essential to the national welfare in agriculture, manufacture, commerce, health and safety. The personnel of all these bureaux operates under the Civil Service.

From the point of view of size of personnel and budget, the scientific services under the Department of Agriculture stand first in the list. Probably these scientific establishments, however, are not so well known generally as those of some of the other departments because their research work is quite largely spread through a great number of agricultural experimental stations distributed throughout the various States of the union and operated co-operatively between the Federal Government and the States. Most of the bureaux in Washington are primarily of an administrative character, but there are several which also conduct centralized research, as, for example, the Bureau of Chemistry and Soils and the Food and Drug Administration. Until recently, the U.S. Weather Bureau operated under the Department of Agriculture, but a few years ago it was transferred to the Department of Commerce, largely because the requirements of air transportation had taken the lead in demanding more accurate and refined methods of weather forecasting than those which had served reasonably well in the past to provide for the needs of agriculture.

Some of the more important of these governmental scientific bureaux are well known; for example, the National Bureau of Standards under the Department of Commerce, the Geological Survey, the Bureau of Mines, and the Bureau of Mineral Statistics and Economics under the Department of the Interior, and the National Institute of Health under the U.S. Public Health Service.

Of particular interest because of its unique character is the National Advisory Committee for Aeronautics, which was established during the War of 1914–18 and which operates three great research establishments. Until recently, the work of the NACA was centred in the aerodynamical research programme at Langley Field, Virginia. Several years ago there was added another aerodynamical research establishment named the Ames Laboratory at Moffett Field, in California, and quite recently still another large research and development establishment for aircraft engines in Cleveland, Ohio. Also, under the NACA, there are currently some eighty research projects being carried on at universities under contract. This obviates unnecessary duplication of facilities in a government laboratory and maintains a group of university scientific workers and engineers in close contact with the problems of aeronautical research.

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* Substance of the Pilgrim Trust Lecture delivered under the auspices of the Royal Society of London on May 20.

The administration of this organization is also unique among our Federal scientific agencies in that its controlling body is a committee which serves without salary and has been composed of men of such high character and distinction as to render it completely free from political influence. This committee is provided with representation from the most interested branches of the Army, Navy and Governmental Departments; but the chairman and the majority control reside in a body of citizen scientists appointed by the President who, in practice, has followed the recommendations of the chairman in appointments to fill vacancies. The present chairman of the NACA is Prof. J. C. Hunsaker, head of the Departments of Mechanical and Aeronautical Engineering at the Massachusetts Institute of Technology, and incidentally, while a very young man, the designer of the first American aeroplane to fly the Atlantic.

Army. Turning now to the United States Armed Services, I can best describe their research and development work as principally a co-operative effort between the services themselves and American industrial companies, with occasional participation from the research laboratories of the technological and educational institutions.

Each branch of the Army contains a technical division under which operate laboratories or arsenals in which a certain amount of research and development work is carried on, the activities of which consist for the most part of testing and proving new war materials or equipment. Thus the technical staffs in the various branches of the Army and Navy have the threefold duty of planning and co-ordinating an extensive programme of research and development carried on in the industrial laboratories, of organizing and conducting research programmes in their own establishments, and of carrying on the extensive operations of proving and testing which result in the acceptance of new devices and the drafting of specifications for production orders.

Among the principal Army establishments in which such work is centred, I would mention particularly those falling under the Ordnance Department, the Signal Corps, the Chemical Warfare Service, and the Army Air Forces. The Ordnance Department operates a great proving ground at Aberdeen, at which is centred most of the proving and testing of ordnance and research on ballistics for arms of all types. In addition it operates five principal arsenals. The Watertown Arsenal is concerned principally with the manufacture of mounts for large-calibre guns and is the principal centre for research and technical service in the field of metallurgy. The Picatinny Arsenal is devoted to the testing of explosives and the design and operation of pilot plants as guides to the industrial producers. The Rock Island Arsenal carries on research and development in the field of oils and lubricants. The Frankford Arsenal supplements the Aberdeen proving ground as a testing and a development centre for small arms. The Tank Arsenal in Detroit is the centre for the design and testing of tanks.

In the Signal Corps the technical division is divided into three principal branches: the Ground Signal Branch, the Electronics Branch and the Aircraft Radio Branch. The research, development and testing work carried on under the Signal Corps is divided principally between the signal laboratories at Fort Monmouth, Camp Evans, Camp Coles, Eatontown and Toms River. The Signal Corps also maintains a large co-operative establishment working with the Army Air Forces at its principal centre, Wright Field.

Until quite recently the research and development work of the Chemical Warfare Service was centred in its great Edgewood Arsenal. As the threat of war came closer, however, a few years ago, and since a very large portion of the facilities at the Edgewood Arsenal are taken up by production, the Chemical Warfare Service established a subsidiary research laboratory and took over for this purpose the newly erected Chemical Engineering Laboratory of the Massachusetts Institute of Technology.

Despite the great expansion of the Army Air Forces, this service has continued to concentrate its research, development and testing activities at its huge establishment at Wright Field in Ohio. There are, of course, other centres at which extended service testing goes on, or at which new equipment is installed in aircraft, but Wright Field remains the headquarters for the research and development work of the Army Air Forces.

The co-ordination among all these various technical services of the Army is maintained by two types of agency. Within each branch of the Army is a board which has general supervision over technical matters within that branch. Examples are the Coast Artillery Board and the Army Engineers Board. When a project has been approved by one of these boards it is next discussed by the appropriate technical committee, composed of members of this branch of the service, and other branches which may be concerned with the project. If this technical committee also approves the project, it goes as a recommendation to the general staff which presumably issues the appropriate directive.

Mention should be made also of the Army Medical Corps, within which a significant amount of research is conducted under the general supervision of the Surgeon-General of the Army.

Navy. The Naval Observatory and the Hydrographic Office, which are under the Chief of Naval Operations, have obvious functions in research and development work. The Marine Corps does some research, but naturally depends to a large extent on the Army and the various bureaux of the Navy. All the bureaux of the Navy Department, Ships, Ordnance, Aeronautics, Naval Personnel, Supplies and Accounts, Medicine and Surgery, Yards and Docks, do research and development work, though naturally the material bureaux conduct the greatest volume.

All research work of the Navy Department is tied together through the office of the Co-ordinator of Research and Development, which office also arranges co-ordination with the Army, with other Government Departments, and with the numerous civilian agencies which I will mention later.

Under the Bureau of Ships, the Naval Research Laboratory near Washington is a centre for all matters of fundamental research including radio, electronics, chemical warfare defence, etc. The David W. Taylor Model Basin, also near Washington, is the primary station for research and development of ship structures, propeller and hull design. The Naval Boiler and Turbine Laboratory at Philadelphia is concerned with all matters of boiler research, testing and design including fuel, composition, quality and nature of boiler fuels, ceramics, etc., and also for research, test and development of main propulsion turbines. The U.S. Naval Engineering Experiment Station at Annapolis, Md., is assigned all problems of research, test and development of mechanical equipment in ships other than main propulsion, and it also has a well-equipped Diesel engine laboratory. The principal metallurgical laboratory for the Bureau of Ships is also located at the Engineering Experiment Station. In New York there is located the Materials Test Laboratory which handles all matters of research, test and development of electrical materials and equipment, acoustical equipment, optical and navigational material and equipment, plastics and allied materials. There are Rubber and Paint Laboratories at Mare Island, California, and an inspection test laboratory in Pittsburgh, Pa., where line production methods for chemical analyses are set up which permit a capacity of about 5,000 chemical analyses a week with a minimum of personnel and equipment. In addition to the above, each Navy yard is equipped with an industrial laboratory to serve the purposes of the yards. It has been found possible to place specialized problems in some of these laboratories, such as the development of chain and rope in the Boston Navy Yard. The assignment and progress, as well as general administration of all research, development and test work, is carried out by the Bureau of Ships in Washington in order most fully and effectively to co-ordinate all work and to collect, apply and distribute the results.

Under the Bureau of Ordnance there are the Dahlgren Proving Ground, the Naval Gun Factory at Washington, the research department of which includes the Naval Ordnance Laboratory, the Naval Powder Factory near Washington and the Newport Torpedo Station. In addition there are establishments devoted to mines, counter-mines, nets and the like.

Under the Bureau of Aeronautics there is the Naval Aircraft Factory in Philadelphia, the Cedar Point Flight Testing Field near Washington, and the Aircraft Armament Laboratory and Testing Field at Hampton Roads.

Research in medicine and surgery is directed by the Research Division of the Bureau of Medicine and Surgery, using many facilities but largely those of the U.S. Naval Medical Research Institute at Bethesda, near Washington, and the Medical Research Laboratories at Pensacola and New London.

Civilian Agencies. I pass now to the non-governmental scientific organizations in the United States, most of the members of which are attached to the staffs of some 600 colleges, universities and engineering schools, some 2,000 industrial research laboratories and other specialized research institutes. Do not be alarmed when I begin by saying that these comprise well over one hundred nationally recognized scientific and engineering societies, exclusive of the social sciences. Of these, only a few are general in scope in the sense that they cover broadly the entire field of science. Largest of these is the American Association for the Advancement of Science, a close parallel to the British Association, with a direct membership of about 24,000 and an indirect aggregate membership of about a million through the 187 associated and affiliated societies. Of a more exclusive character and without the affiliated and associated societies are the American Philosophical Society and the American Academy of Arts and Sciences.

Unique among the scientific organizations of the United States is the National Academy of Sciences. In March 1863, during a crisis of our Civil War, Congress established the National Academy of Sciences, and President Lincoln signed the Act of incorporation. This Act specified that "the Academy shall, whenever called upon by any department of the governments, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be made from appropriations which may be made for the purpose". There was also the provision in the charter that, except for the actual expenses of these activities, neither the Academy nor any member of the Academy is entitled to receive any compensation whatsoever for such services. Although the membership is legally limited to 450, the actual membership in the Academy has never exceeded its present enrolment of 350.

Outside its services in war-times, perhaps the most noteworthy public service by the Academy was its geological and engineering investigation of the slides which at one time threatened to prevent the successful consummation of the Panama Canal. However, the utilization of the Academy by the Government has been rather 'spotty'. Under some administrations the Academy has been used rather extensively and in other administrations has been more or less forgotten by the Government. In this respect I believe that the Royal Society has had a more consistent role of usefulness.

One inevitable characteristic of this type of organization, in which membership is considered to be the highest scientific honour of the country, is that membership, like scientific recognition, is likely to come to a man after he has passed the peak of activity in his scientific career. For this reason the Academy has been able to perform an excellent function of the 'scientific elder statesmen' variety. It has zealously kept itself free from all types of political influence. Its ideals have been unselfish service, integrity and scientific competence. Frequently, however, probably in the great majority of cases, when a very active research programme has to be undertaken, many of the personnel best adapted for the particular job are not found within the membership of the Academy.

During the War of 1914–18 in Europe, but before the United States had become a participant, President Wilson by executive order requested the National Academy of Sciences to establish the National Research Council as a measure of national preparedness. This organization operated so usefully during the war that in April 1919 the National Research Council was perpetuated by the National Academy of Sciences at the express request of President Wilson.

This National Research Council is organized into nine permanent divisions covering the various fields of scientific research and of scientific administration. These divisions are composed of appointed members and also of representatives from many of the scientific and engineering societies and branches of the Government. Because of this wide representation the National Research Council is a most effective agency for finding just the right persons to do any specific scientific job.

During the present War the National Academy and the National Research Council have been called upon to perform many important services, some of an advisory character and some involving the placing of contracts for research and development work in various laboratories.

Among the nearly two hundred committees operating under the National Research Council, the following are typical of those concerned with the War: aviation medicine, war metallurgy, passive protection against bombing, war use of research facilities, tin smelting and reclamation, clothing, shock and transfusions, treatment of gas casualties, war-time diet, and selection and training of service personnel.

War-time Scientific Organization

In spite of the apparently complete peace-time organization which I have just described, it has always been our experience, in the time of great emergency, that it appears advisable to establish temporary new agencies to deal particularly with the emergency.

I have frequently tried to analyse the reasons for the establishment of special scientific agencies during times of crisis. They are, I think, varied and rather fundamental. One of them is that every great crisis involves conditions so different from the normal situation that the types of organizations which can survive and operate during peace-time are not adequate to meet the emergency. It may be, for example, that the emergency calls for exercise of very extensive administrative functions, such as the supervision of research projects and the disbursement of large governmental funds to a far greater extent than in peace-time. Hence a peace-time body of scientific men organized primarily to exercise advisory functions may not be organized in a manner suited to prompt and efficient executive action. Another reason is the impossibility of always maintaining in the administrative positions of peace-time agencies the personnel who would be most effective for handling important projects in a war emergency. Men who have the proper capabilities are frequently too busy and too active in other directions to be willing to hold positions in a peace-time organization which is relatively inactive. Consequently when the emergency comes, the only alternatives may be to change the leadership in the existing organizations, a difficult if not impossible process, or to set up new temporary agencies to deal with the emergency.

Whatever the reasons may be, this present war emergency has run true to form and has resulted in the establishment of a group of special agencies of temporary character which I shall proceed now to describe. It is these agencies which are carrying the principal burden of the scientific research and development work related to the War, in the United States.

The National Roster of Scientific and Specialized Personnel was established early in July 1940, when President Roosevelt approved a project for making available in one central office an index of all American citizens who have special scientific or professional skill. Headed by President Leonard Carmichael of Tufts College, this agency operates under the War Man-power Commission under the Office for Emergency Management of the executive office of the President. As a result of information secured from questionnaires sent to all members of all scientific and professional organizations in the United States, and supplemented by other information, an elaborate punch-card system has been set up in which practically every person in the country with specialized training or skill is listed with reference to his or her major professional fields and with the addition of a great deal of supplementary information regarding special interests, languages read or spoken, foreign countries travelled in, previous experience in the Armed Services or in industry, etc.

There are altogether fifty-nine special fields listed in the Roster, falling under the general categories of administration and management, agricultural and biological sciences, engineering and related fields, humanities, medical sciences and related fields, physical sciences, and social sciences. At the present time the total number of persons in this Roster is about 600,000, including, as of last October, 71,511 chemists, 7,297 mathematicians, 10,080 physicists or astronomers, 4,559 radio engineers, 14,729 electrical engineers, only 408 professional philosophers, and the smallest entry in the list is 142 spelæologists.

The Roster was originally conceived to serve governmental agencies which might request information on scientific personnel. More recently, as serious man-power shortages have developed both in industry and in education, and as the Armed Services have become more and more concerned over the most effective use of all scientifically trained personnel, the Roster has been used to an increasing degree in connexion with placement work and to give the supply and shortage data on professional groups. Up to the middle of last month the National Roster had certified more than 140,000 names of specialists to various agencies engaged in the war programme in the United States.

Office of Scientific Research and Development (OSRD). Most important of the scientific agencies established specially to deal with problems of this War is the Office of Scientific Research and Development, the director of which is Dr. Vannevar Bush president of the Carnegie Institution of Washington It was created by executive order of the President in June 1941 and under it operate the National Defense Research Committee, which had been established just a year earlier, and also the more recently established Committee on Medical Research. The OSRD is directed to co-ordinate, and where necessary supplement, the scientific research and development work relating to the War among civilian agencies as well as those of the Government, including the Armed Services. To facilitate this co-ordination the advisory council to the director of the OSRD includes high ranking representatives from the War and Navy Departments, the chairmen of the National Advisory Committee for Aeronautics, the National Defense Research Committee and the Committee on Medical Research and, by invitation, the president of the National Academy of Sciences and the director of the newly established Office of Production Research and Development of the War Production Board.

The principal research and development activities of the OSRD are carried on under contracts with appropriate research institutions, these contracts being financed out of an annual Congressional appropriation. At the present time these contracts involve expenditures at the rate of about 100,000,000 dollars a year, and there are currently active about 1,400 contracts with about 200 industrial laboratories and 100 educational or special research institutions. About 6,000 scientific workers and engineers of professional grade are engaged on these contracts, with the assistance of a considerably larger number of technicians of various types.

To facilitate interchange of information between the OSRD and our British colleagues, an OSRD Liaison Office was established with offices in Washington and London, now headed by Dr. Caryl P. Haskins and Mr. Bennett Archambault, respectively. These in co-operation with the similar liaison services of Great Britain, Canada and, less extensively, Australia and South Africa, have served well to knit together our joint scientific efforts.

The National Defense Research Committee (NDRC) operates to recommend to the director of the OSRD research and development contracts in the field of instrumentalities, devices and mechanisms of warfare. Under the chairmanship of President James B. Conant, of Harvard University, this committee is composed of four civilian men of science, plus one representative each from the Army and Navy, and the Commissioner of Patents. Feeding into it come the recommendations from nineteen divisions, most of which are subdivided into several sections. These divisions and sections are each built around a specific functional concept such as fire control or sub-surface warfare or explosives. However, there are two divisions which are in the nature of 'catch-alls'; for example, the Division of Physics and the Division of Chemistry can be defined as handling everything in these respective fields which does not fall into any one of the more sharply defined divisions.

In addition to the nineteen divisions of the NDRC there are two panels concerned respectively with applied mathematics and engineering. The difference between a division and a panel is suggested by the fact that the Fire Control Division, for example, is concerned with the development of fire control instruments, whereas the Applied Mathematics Panel is not concerned with the development of applied mathematics as such, but rather with the use of mathematics to aid in accomplishing the objectives of the various divisions. For this reason the applied mathematics panel includes membership on each divisional committee in which applied mathematics is likely to be important. The Engineering Panel serves all the divisions to expedite the transition from the stage of research and development to the stage of quantity production under Army or Navy contract.

Intimate contact between the NDRC and its divisions on one hand, and the Armed Services on the other, is maintained at several levels by an extensive organization of Army and Navy liaison officers, who have proved invaluable as channels for acquainting the NDRC with the needs and desires of the Armed Services for new equipment, and for making arrangements for demonstrations and service tests.

Proposals for research or development projects come to the NDRC from a wide variety of sources—requests or suggestions from the Army or Navy, proposals from industrial or academic research laboratories, promising inventions transmitted to the NDRC from the National Inventors' Council, or in many cases projects originating within the NDRC committees themselves. However, the NDRC has complete freedom in making its decisions on the projects which it recommends to the director of the OSRD and the priority attached to these projects, and the director of the OSRD has complete freedom in his own judgment to authorize the recommended contracts.

For reasons of security no person serves as a member of any NDRC committee unless he has been 'cleared' by the Army and Navy Intelligence Offices, after investigation. Similarly, all personnel of the contractors working on the research and development projects are 'cleared' by these intelligence offices to whatever degree is deemed advisable in virtue of the degree of secrecy attached to the project.

The Committee on Medical Research (*CMR*), under the chairmanship of Dr. A. Newton Richards, of the Medical School of the University of Pennsylvania, is in every respect parallel to the National Defense Research Committee in its organization and methods of operation. It deals exclusively with problems of war medicine such as shock, immunization or protection against types of diseases characteristic of the present theatres of war, etc. Though considerably younger and smaller than NDRC in both personnel and budget, it already has a record of substantial accomplishment.

Joint Committee on New Weapons and Equipment (JNW). The organizations described thus far have proved effective in organizing and administering research projects and in maintaining close relationships and exchange of information with the Armed Services and our British allies. In respect to the Armed Services, however, these relationships are primarily at the research and development level, and for a time lacked one very important element necessary to make the work fully effective in the War. This missing element was an intimate relationship between the research and development agencies and the highest command of the Army and Navy, who have the responsibility of planning the military or naval operations in which newly developed weapons might be used effectively or for which new devices should be developed.

In order to fill this gap, the U.S. Joint Chiefs of Staff in May 1942 established the Joint Committee on New Weapons and Equipment, composed of Dr. Bush, director of OSRD, as chairman, the Assistant Chief of Staff G4 of the Army (now Brigadier-General Moses), and the Chief of the Readiness Division of the Navy (now Rear-Admiral De Laney). JNW is charged by the Chiefs of Staff with correlating the research programme of Army, Navy and civilian agencies. It acts through subordinate bodies, of which the special mission in which I am presently engaged in England is an example.

Through JNW any new weapon the potentialities of which appear to be unusually significant is brought directly to the attention of the High Command for their consideration in the planning of future operations. Conversely, JNW offers a direct channel through which the High Command can pass down to the research scientists a request for development of any particular instrumentality which could be particularly effective in connexion with some contemplated operation. This type of liaison between the scientific workers and the High Command is new in the United States. Its possibilities are still being explored and developed, but it can be said definitely that it has already demonstrated its possibilities of great value in the War. It is a move in a desirable direction in which Great Britain has gone farther than the United States.

National Inventors' Council. War is a great stimulus to invention, not only in the research laboratories of a country, but also on the part of great numbers of its citizens, some of whom are technically competent and most of whom are uninformed but sincere in their desire to be helpful. Any actively operating research organization like the OSRD or the Naval Research Laboratory could be quickly bogged down under the deluge of ideas and inventions induced from all sources by the War. It is very important for purposes of morale that these inventors and would-be inventors be sympathetically handled. It is also important that their ideas be expertly examined to make sure that ideas really worth while are not brushed aside, even though experience has shown that perhaps only one in one hundred thousand is new and significant. To give such sympathetic and expert consideration and to screen the interesting suggestions out of the great mass, the National Inventors' Council was established in June 1940, in close association with the U.S. Patent Office in the Department of Commerce, under the chairmanship of Dr. Charles F. Kettering, vice-president in charge of research for the General Motors Corporation. All suggested inventions relating to the War from any source and submitted to any agency or person in the Government are channelled through this National Inventors' Council (unless they happen to come initially to an appropriate agency which is immediately interested in pursuing the matter). They pass through the hands of an expert staff of examiners who select those inventions which appear to have merit and bring them to the attention of the appropriate agency.

Office of Production Research and Development of the War Production Board. Until recently, the organized war research efforts in the United States failed to include the very important category of research aimed at the development of substitute materials in fields where shortages exist, or of improved methods of production and manufacture. It was apparently assumed that the commercial interest of the production companies would lead them automatically to take care of this situation. However, under the pressure of war production orders, limitations of man-power and materials, and financial regulations, the normal peace-time incentives to such research and development work by companies proved inadequate to meet the needs of the situation. Consequently, last September, there was established in the War Production Board an Office of Production Research and Development under the directorship of Dr. Harvey N. Davis, president of the Stevens Institute of Technology. This agency is still in the process of organization to operate somewhat along the lines of the Office of Scientific Research and Development, but with primary responsibility for materials and method of production rather than devices and instrumentalities of warfare. It is regrettable that we did not have the foresight to establish this much needed agency at a much earlier date, but it has already begun its operations and we hope that it may be enabled to play an important role during the balance of the War.

Engineering, Science and Management War Training Programme. Though not directly concerned with scientific research, a review of the scientific war agencies in the United States would not be complete without at least a brief reference to the efforts to increase the supply of technically trained personnel to meet the increasing demand for such personnel in every field of war activity. In October 1940 a special engineering training programme was organized under the U.S. Office of Education and financed by Congressional appropriation. Later, this programme was extended to include also training in science and industrial management. It operates at both the collegiate and the technical school levels and its magnitude may be appreciated by the fact that, even in its first year of operation, it put through its specialized courses approximately ten times as many students as graduated in that year from the regularly established engineering colleges. Most, but not all, of the work was carried on in night schools, and th whole programme has been decidedly helpful i relieving the technical man-power shortage.

Army and Navy Technical Training Programme At the present time the Army and Navy are jointl establishing a very extensive programme for th training of their own younger personnel in such field as aeronautical engineering, naval architecture, electronics, communications, automotive engineering etc., through contractual arrangements with severa hundred of the nation's colleges and universities Under these programmes it is anticipated tha approximately 250,000 selected young men in uniform will be detailed for this training at educationa institutions during the coming year, the duration o such training to vary from field to field and individua to individual, in accordance with the needs of th situation and the performance of the individual These special collegiate programmes are intended t supplement, at the higher level, the very much large technical training programmes which the Army an Navy are conducting in their own establishments.

Conclusion

I conclude this factual, over-long, but I hope usefully informative address on a note of faith an optimism which I am sure is shared by the allie men of science on both sides of the Atlantic. Eac of us concerned with some phase of the war effor is aware of some very significant new applications o scientific research in the War. For most of us, thi knowledge is largely restricted to the special field in which we ourselves have been working. Of necessity, the general public knows only in a vague wa about some of these things and nothing at all abou most of them.

When victory has been won, and the whole stor of these scientific accomplishments can be told, i will indeed be a thrillingly interesting recital. Ou of it all will come, not only its important contributio to victory, but also a number of exceedingly significant results of permanent peace-time value. It i already evident that many of these war-time developments will have very useful peace-time applications the contributions of which to our standards of living and general prosperity and comfort will help t compensate for the ravages wrought by the War Scientific men will have a renewed faith in the worthwhileness of their work, and will continue thei intellectual and practical endeavours with the increased power that has come from the experience o 'team-work' on war problems. The general public and especially the governmental and industria leaders, will have greater appreciation of the valu of science and scientific workers, both pure an applied; and this should result in permanentl increased support of scientific research in the universities, industries and governmental agencies. These I trust, will be some of the long-term gains to whic we may look forward as the result of the temporar concentration upon practical problems of surviva and victory which the War has forced upon us.

With these words of optimism, I close with th hope that the next American Pilgrim Trust lecture may not feel obliged to discuss the War, but will b able to treat of some interesting aspect of the progress of science in accord with the original conceptio of Sir William Bragg and as a happy feature in th post-war forward march of science.

SCIENCE AS A HUMANITY

By Prof. W. G. de Burgh, F.B.A.

The session on "Science as a Humanity" held during the recent British Association Conference on "Science and the Citizen" is of good augury, for it is a further testimony to the fact, evident of late in many quarters, that the old rivalry of science and the humanities is a back number, and is rapidly ceasing to cast a cloud over the future of our national education. There has always been something unnatural about the controversy; for, as Prof. J. L. Myres reminds us in his opening address as well as Dr. Waddington at the close, both the parties share a common parentage in the epoch of the Renaissance, inheriting therefrom an identity of aim and interest that is belied by their artificial severance. We can picture how Copernicus, Kepler and even Harvey would have recoiled from the suggestion that the study of classical antiquity was irrelevant, not to say inimical, to that of the sciences of Nature. If later generations have emphasized the contrast, to the detriment both of science and the humanities, the responsibility lies chiefly with a philosopher, Immanuel Kant. For Kant, science meant Newtonian physics; man's moral personality and the entire realm of ethical and religious value were excluded from the knowledge of speculative reason and regarded as objects of practical faith. No wonder that such limitation of the scope of science provoked a protest, of which Wilhelm Dilthey was the leading champion in Germany, to the effect that over and above the sciences of Nature were the sciences of spirit (*Geisteswissenschaften*) which were none the less deserving of the name of sciences, though their objects and methods were poles asunder from those of mathematical physics.

Science is an ambiguous term and both Prof. Myres and Dr. Waddington see the necessity of clearly understanding what we mean by it. Kant's use is far too narrow, for it would scarcely include biology, to say nothing of psychology or anthropology. On the other hand, to take it as the equivalent of the German *Wissenschaft* is far too wide; if every inquiry that employs an elaborate technique is a science, then not only are history and archæology sciences, but also all the departmental researches of the pundits of the British Museum, and the higher criticism of the Old and New Testament, deserve that title; and what branch of knowledge is then left over for the humanities? Dr. Waddington, though he endorses Prof. Myres's inclusion both of the "interactions of individuals, which are incommensurable qualitatively, and of value" within the scope of science, dissents from the view, sometimes put forward by scientific advocates of the wider interpretation, that science can be stretched to cover "all the achievements of logical or rational thought". Science, for him as for Prof. Myres, is the product of the wedlock of reason and experiment, and the empirical, if not always the experimental, factor is an essential constituent of its meaning. That, he claims justly, is the hall-mark of Greek culture, "a culture of quick-witted, subtle Individualists interested on the one hand in deep speculative generalisations, and on the other in highly practical matters of an empirical nature". What is distinctive of the humanities, he tells us, is that they are grounded on "feeling applied to the individual". This definition may be accepted, provided always that the term "feeling" is not taken to exclude the possibility of a knowledge of the individual such as is achieved through history, through literature and the arts, and through personal relationships between man and man and possibly—though this is a larger question—between man and God, a knowledge which is none the less rational in that it is closely integrated with emotional and volitional activity. That this personal knowledge can function even within the strictly scientific fold, for the untold enrichment of the conceptual thinking that properly characterizes science, will scarcely be disputed by those who appreciate the intimate contacts with birds and other animals enjoyed by such lovers of Nature as W. H. Hudson or the late Lord Grey of Fallodon. A wide field for reflection is here thrown open, very relevant to the topic of the cultural value of science; by the co-operation of the personal and impersonal methods of inquiry.

Among those who took part in this conference, Dr. R. V. Southwell is the one who seems to appreciate this most clearly. He points out that what is requisite for the training of the citizen's personality cannot be restricted to the technique of the laboratory, or even to "acquaintance with scientific thought". This indeed is necessary, but it is not sufficient. Science calls for supplementation by the humanities. "No less needed", he says in a highly instructive passage, "is the thinking that reveals itself as wisdom in the affairs of life itself. The humanists claim that it is developed by their studies, and I think I have noticed in many of them a suppleness (if the word will serve) which men of science too often lack. Here then is a case for 'the humanities' in a balanced education, and in my belief they are an essential part: though I am by no means satisfied with the way in which they are studied under our examination system, and can perceive, I think, the danger of a teaching so completely based upon authority. Too often, dislike of the premature conclusion leads to a shunning of decisions in a world where decisions are imperative. But what is still wanting, science, I believe, can give: realization that hard problems require hard thinking, and that the effort must be made." This is excellently said, and carries a lesson both for the scientist and the humanist. It may be that Dr. Southwell exaggerates the deference to authority in current humanistic teaching, and glozes with natural partiality over the excessive conservatism that has often prejudiced original advance in science. But the ready response that his *eirenicon* will evoke in humanist quarters may be gauged by a reference to the Provost of Kings' presidential address at the recent meeting of the Classical Association at Cambridge. He will have none of the familiar party slogans: "I am for the Classics", "I am for Religion", "I am for Science", and appeals to the temper of Erasmus, typical of the great days of Humanism, and still prevalent in English education in the seventeenth century. "Would Harvey of Caius," he asks, "who discovered the circulation of the blood, have done better in his science if he had been sent to an expensive, well-taught, well-laboratoried secondary school and had sat at school for his M.B.?"

Of course, there are difficulties in the way of realizing the union of the scientific spirit with that of humanism in a concrete educational programme. Are arts subjects to be added to science courses, and science subjects to courses in arts? Or is science to be taught culturally so as itself to be a humanity in its own right? Both lines of approach should be tried, after the true scientific method, experimentally. Only the other day, the late Prof. Muirhead, then the doyen among English philosophers, publishing his reminiscences as an octogenarian, recalled the arts curriculum at Glasgow in the seventies of last century, which still kept alive its fidelity to the medieval tradition. He gives as his reasoned opinion, formed after experience of the Oxford system and that of the new English universities and of several of the great American universities, both State and other, that, "for breadth of training and as a preparation either for business life, for the professions, or for further specialized study, there is nothing which, on the whole, has proved better than this old Quadrivium of Classics, Mathematics, Philosophy and Physics, all softened and humanized by a halo of English literature". Then there is the further problem of finding teachers of science able and willing to bring home its cultural significance to students without experience of a laboratory. The tradition that the training of highly specialized researchers alone is the concern of the teacher of science is so strongly rooted that the cultural value of science has almost vanished from the picture. The arts student in our universities has no opportunity of learning the bearings on human life of the mysteries that are being enacted within the precincts of the laboratory. There is serious need for lecturers to mediate between the specialist and the public, possessed of the gift for expounding, like Huxley in his generation, or Bertrand Russell, in his "A.B.C. of Atoms", the leading currents of contemporary scientific thought in language intelligible to the thinking public.

All the speakers at this Conference, except perhaps Prof. Le Gros Clark, who confines his remarks to the teaching of biology and its applications to the education of the citizen, recognize that it is the task of science to throw light on the problem of moral value. Dr. Waddington, as we should expect from his recent volume on "Science and Ethics", which has deservedly arrested the interest of the public, believes that evolutionary science offers the key to its solution. That "man himself is, after all, a member of the animal world" is, of course, a truism of which we do not need the biologist to assure us; it was well known to antiquity, and there is a mass of contemporary evidence to bring home to us how close the ape and the tiger lie to the surface of human nature. But man is not merely an animal; he is a thinking animal, an animal with a moral consciousness, capable of extending his outlook both in thought and action beyond the bourne of time and space.

In my contribution to Dr. Waddington's book, I ventured to question whether the appeal to evolution could justify the absolute claim of moral obligation. Dr. Waddington's suggestion, reiterated at this Conference, that "the highest duty of man should be to carry forward the main stream of evolution" seems to make larger drafts upon the future than is warranted by our knowledge of the course of evolution. Does that knowledge really bear out Prof. Myres's contention that, despite the tragic antithesis of the ethical and cosmic processes, "good must win"? Prof. Myres adds the proviso, "if all good men work together in the cause of good". Can evolutionary science enlighten us, as Dr. Waddington believes it can, as to the nature of what is good? The menace of entropy is surely enough to give us pause. Even if we restrict our view to the facts of recorded history, what evidence do we find of uniform advance in human morals? Does it not look to-day as if the human race were moving rapidly and of deliberate purpose down the slope that leads to self-destruction?

Dr. Waddington closes his address with some pertinent remarks on the trend towards socialism, characteristic of the modern cultural outlook, and suggests that science, by emphasizing man's essentially social nature, may play a "by no means negligible part in bringing the new society to birth". He holds that as in the humanism of the Renaissance, a purely this-worldly individualism, which found appropriate embodiment in art, superseded the other-worldly sociality of the Middle Ages; so a this-worldly sociality is destined to replace the individualism of the capitalist epoch that is now in process of disintegration, with science as its fitting medium of expression. Science will thus replace art, as art replaced religion, as the predominant human interest.

But is this picture of the dialectical process true to fact? Has interest in art shown any tendency to decline, for example, in Soviet Russia? And what about religion? "En mon temps on avait Dieu", said the old French marquis in the play; and it sometimes looks as though even in Russia they had him still. It is at all events matter for argument whether theism cannot offer a more promising solution of the problem of value than the optimism which pins its faith to the evolutionary process. But this is a view which, I fear, would scarcely find favour among those who collaborated in this Conference.

OBITUARIES

Dr. Henry Forster Morley

THE death of Henry Forster Morley occurred on April 3, 1943, in his eighty-eighth year. He was well known to chemists and other scientific men, both in Great Britain and abroad. Over a long period of time Morley and his wife, who died only a few weeks before him, were frequent visitors at scientific gatherings and until recently they customarily attended the conversaziones and evening meetings of the Royal Institution.

Forster Morley, born on October 23, 1855, was the eldest son of the late Prof. Henry Morley, sometime professor of English literature at University College, London. He was educated at University College School, University College, London, and proceeded to the Universities of Paris, Berlin and Bonn. He was assistant professor of chemistry at University College, London, in the time of Williamson's professorship. He also held the posts of professor of chemistry at Queen's College, London, and lecturer in chemistry at Charing Cross Hospital. He acted as examiner in chemistry to the Universities of London, Oxford, to the Conjoint Board, the Society of Apothecaries and elsewhere.

In addition to his original publications in chemistry, Forster Morley prepared, in 1899, in conjunction with Patterson Muir, a revised edition of "Watt's Dictionary of Chemistry", a work which still continues to serve useful purposes. The text-book of organic chemistry he published in 1884 has lasting merit, inasmuch as in dealing with the practical relationship, properties and preparation of organic substances it arouses the student's interest in these aspects before his attention is concentrated on the theoretical framework of organic chemistry. It is a remarkable fact that this text-book is still in use. He also acted as director of the central bureau concerned with the preparation of the International Catalogue of Scientific Literature published by the Royal Society. The first annual issue of this great work under his directorship was published in 1903 and annual issues followed up to the fifteenth, dealing with the year 1915, after which the work was suspended owing to the War of 1914–18. After peace came, there were great difficulties in the way of resuming the work, and in 1922 it was decided not to continue it further.

Morley's earliest scientific publication appears to have been a paper on the Groves gas battery published in 1878. Another paper published in 1878 was one with L. Claisen describing the preparation of phenylglyoxylic acid and its ethyl ester by the interaction of ethyl oxalyl chloride and mercury diphenyl. In 1879 he investigated, with C. Wurster, the methylation of *m*-phenylene diamine and obtained the tetramethyl derivative. He also examined the action of nitric acid on the new compound. In the same year he studied the action of nitrous acid on diphenylethylene diamine and diphenyldiethylene diamine, obtaining the nitrosamines, from the second of which he prepared diphenyl diethylene tetramine.

In 1880 some work on bases allied to choline was published. The interaction of monochlorhydrin with mono- or dimethylamine was found to give methyl diox-ethylene diamine and the corresponding dimethyl compound. The action of propylene and *iso*-propylene chlorhydrins with trimethylamine gave the trimethyl hydroxy propylamine chloride and the corresponding *iso* compound. By the interaction of chlorhydrin with mono- and dimethylamines he obtained the mono- and dimethyldioxy ethylene amines.

In 1882 the action of an aromatic amine (*p*-toluidine) and propylene oxide was tried, and oxypropyl *p*-toluidine was isolated as a crystalline solid. In 885 he worked with A. G. Green on the constitution f the propylene chlorhydrin obtained from glycerin. t was shown to be mainly $CH_3CH\ OH\ CH_2Cl$, but an dmixture of the isomer was not excluded. The ction of zinc ethide on the benzoyl derivative of the hlorhydrin was investigated and found to follow a omewhat unexpected course, giving rise to a member f a new series of compounds which were named ketates'. In the course of this work propiophenone was prepared for the first time in solid form. In the ame year, in conjunction with W. J. Saint, he prepared and investigated ethyl thioxalate. Two years ater he wrote some criticism of H. E. Armstrong's iews on substitution in the benzene nucleus. In 891 he published, in conjunction with E. Hari, an ccount of the *p*- and *iso*-propyl *p*-toluidines.

Morley did not entirely retire until he was eighty-our, when he resigned from his last examinership on is wife's persuasion—although he was asked to ontinue for a further year.

A man of happy disposition and simple tastes, he oved to welcome his friends to his house at Hamp-ead or to his quiet home and garden in Midhurst, he peace of which was rudely disturbed by enemy ction a few weeks before his death. He himself ortunately escaped injury.

FRANCIS H. CARR.

Prof. A. A. Boon

THE death occurred in Edinburgh on April 1 of Prof. Alfred Archibald Boon, emeritus professor of chemistry in the Heriot-Watt College. He was seventy-six years of age, unmarried, and had been in failing health for some years.

Born in India, where his father was in the Indian Medical Service, Boon graduated B.A. at the University of Madras, then went to the University of Edinburgh to study chemistry under Crum Brown and natural philosophy under Tait, whose lectures appealed to him very much. He graduated B.Sc. in 1898, then took the D.Sc. degree in 1905, his researches being in the field of organic chemistry. Boon was always keenly interested in the medical and pharmacological aspects of chemistry.

For some years Boon was on the staff of one of the training colleges in Edinburgh and was also a part-time member of the chemistry staff of the Heriot-Watt College. On two occasions, he conducted courses for teachers in Dublin on the invitation of the Board of Agriculture and Technical Instruction for Ireland. He soon became a full-time member of the staff of the Heriot-Watt College as lecturer in organic chemistry and, on the death of Prof. John Gibson, became acting head of the Chemistry Department in 1913. In 1919, he was appointed professor of chemistry, a post which he held until his retirement in 1931 with the title of emeritus professor.

Boon was a very able teacher and took great care in the supervision and administration of his Department, which developed greatly under his direction, among the developments being courses in paper-making, brewing, and pharmacy. The interests of his Department and of his students came first; he never seemed to forget a student. The heavy administrative and teaching work he had to bear gave him little opportunities for research, to which, however, he made contributions. In all his teaching he always stressed the great importance of fundamental principles.

During the War of 1914–18, he undertook investigations for the Services, particularly for the Admiralty, such as the systematic examination of oils collected from the surface of the North Sea whenever a German submarine was destroyed, the first of these being at Fidra in the Firth of Forth.

On several occasions, Boon served on the Council of the Institute of Chemistry, he was for many years a member of the Board of Examiners in Scotland of the Pharmaceutical Society of Great Britain, and served on several committees dealing with the training of pharmacists.

A man of deep religious convictions, Boon was a hater of injustice, was very conscientious, fair-minded, and helpful to any who sought his aid or advice. A cricketer and a swimmer in his younger days, he took up golf in later years and enjoyed his holiday in North Berwick; he became an able player, as many of his friends found. To those who knew him he was a true friend.

F. J. WILSON.

WE regret to announce the following deaths:

Sir Thomas Middleton, K.C.I.E., K.B.E., C.B., F.R.S., chairman of the Agricultural Research Council since 1938, on May 14, aged seventy-nine.

Sir Arthur Newsholme, K.C.B., sometime principal medical officer under the Local Government Board, on May 17, aged eighty-six.

NEWS AND VIEWS

Chair of Biochemistry in the University of Cambridge

Prof. A. C. Chibnall, whose appointment to succeed Sir Frederick Gowland Hopkins as professor of biochemistry in the University of Cambridge has recently been announced, has for some time been recognized as one of the most distinguished biochemists in Great Britain. Since the time when, following upon a period of study with the late T. B. Osborne in Newhaven and some years of work at University College, London, Prof. Chibnall succeeded the late S. B. Schryver at the Imperial College, he and his pupils have maintained a steady output of work on problems of plant biochemistry. His earlier work was chiefly concerned with lipoid constituents of plants; this subject had formerly been in great confusion, and Chibnall, with the aid of his own highly developed chemical technique reinforced by valuable collaboration in X-ray analysis from Dr. S. H. Piper, was the first to bring it into order. Later he devoted more attention to proteins and other nitrogenous constituents of plants in relation to problems of nitrogen metabolism; this work formed the subject of his Silliman lectures and of the monograph which he based on them. More recently Chibnall has become interested in fundamental problems of protein structure, to which he has made important contributions, adopting the analytical approach and constantly insisting on the precision of technique which has been characteristic of all his work. Prof. Chibnall therefore leaves the important school of plant biochemistry, which he has built up at the Imperial College, with a wide experience behind him and well fitted to take charge of the most distinguished biochemical laboratory in Great Britain.

Chair of Chemistry in University College, Bangor

Under the late Prof. Kennedy Orton, the Department of Chemistry of the University College of North Wales, Bangor, became one of the first of those modern schools of research which are concerned with the elucidation of the nature and mechanism of the reactions of organic chemistry. It therefore seems appropriate that Dr. Edward David Hughes, one of Prof. Orton's many distinguished pupils, should follow Prof. J. L. Simonsen in Prof. Orton's chair. After graduating in Bangor with first class honours in chemistry in 1927, Dr. Hughes commenced, under the leadership of his professor and of Dr. H. B. Watson, then on the College staff at Bangor, his first researches in the general field to which he has contributed so considerably. For this work he was awarded the Ph.D. degree and a studentship of the University of Wales in 1930. In that year he proceeded to University College, London, and there, first as a research student under Prof. C. K. Ingold, than as a research fellow, and finally as a member of the College staff, he continued the work which brought him in rapid succession the highest research degrees of the University of London, the British Ramsay Fellowship, and, in 1936, the Meldola Medal of the Institute of Chemistry (awarded for the most distinguished chemical work carried out under the age of thirty). Dr. Hughes is author or joint author of more than seventy papers published in British and American scientific journals. His most noted work relates to the establishment of ionization (or 'heterolysis') as controlling phase in a large class of substitution and elimination reactions of saturated molecules and ions, the discovery of the rules governing the spatial orientation of substitution (including a demonstration, by the use of radio-halogens, of the invariability of Walden inversion in bimolecular substitution), and the elucidation of circumstances which control the appearance of steric hindrance in substitution processes.

Chair of Physics at University College, Dundee

Mr. G. D. Preston, whose appointment to the Harris chair of physics at University College, Dundee, has recently been announced, is best known for his applications of physical methods to metallurgical problems. After leaving Cambridge, he joined the staff of the National Physical Laboratory, working first in the Physics Department and later in the Department of Metallurgy. His chief interest has lain in X-ray crystallography and more particularly in its applications to metallurgy. In collaboration with Prof. E. A. Owen, he was one of the pioneers in the investigation by X-ray methods of alloy systems, and succeeded in determining the structure of various alloys and alloy systems. In addition to his work in the X-ray field, he has also applied the method of electron diffraction successfully to problems of metallurgy and to the study of corrosion. He was one of the first in Great Britain to construct and use the electron microscope. Mr. Preston's more recent work has been concerned with the age-hardening of alloys. During these investigations he found the diffuse X-ray reflexions which have been the subject of so much experiment and discussion of late. His work has thrown much light on their nature and origin. His researches have been notable for the fact that they have been carried out almost entirely with apparatus designed and constructed in his own laboratory, and much ingenuity has been shown in producing equipment essentially simple, but eminently suited for the task in hand. It is to be hoped that in his new sphere Mr. Preston will have ample opportunities for further research.

Royal Society: New Foreign Members

At a meeting of the Royal Society on May 20, the following were elected foreign members:

Dr. Bernardo Albert Houssay, professor of physiology in the University of Buenos Ayres. He is distinguished for his researches on endocrine glands and is a leader of an important centre of biological research.

Dr. Victor Moritz Goldschmidt, professor of mineralogy and geology in the University of Oslo since 1936. He was formerly professor of mineralogy and petrology in the Universities of Oslo (1914–29) and Göttingen (1929–36). He has made fundamental contributions to petrology on the genesis of the crystalline schists in progressive metamorphism, while his researches have laid the foundation of the science of crystal chemistry. In geology, using chiefly the methods of analysis of quantitative optical and X-ray spectroscopy, he has determined the principles that govern the minor elements in the earth's crust and meteorites.

Royal Society of Arts: Albert Gold Medal

The Albert Gold Medal for 1943 of the Royal Society of Arts has been awarded to Sir John Russell, director of the Rothamsted Experimental Station. The Medal, which was struck in 1864 to commemorate the presidency of the Society held by Prince Albert during 1843–61, is awarded "for distinguished merit in promoting Arts, Manufactures and Commerce". Fifty years ago the Medal was awarded to Sir John Bennet Lawes and John Henry Gilbert "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted".

Prof. K. A. Timiriazev, For.Mem.R.S. (1843–1920)

The centenary of the birth of Prof. K. A. Timiriazev will be celebrated on June 3 at the Timiriazev Agricultural Academy, where the jubilee session will be held. Timiriazev, one of the foremost men of science of his day, was an honorary and active member of more than forty academies of science and universities. In 1911 he was elected foreign member of the Royal Society. His scientific researches were confined almost solely to the photosynthetic activity of the green leaf; the application of scientific achievement to practical life was closely bound up with his experimental work. He blazed a new path in the field of application of plant physiology to agriculture, in the field of science teaching, and in the field of the popularization of science. In 1908, Timiriazev wrote: "In the world-wide struggle between that part of mankind which looks ahead and that part which is fatally destined to gaze retrospectively, the following words will be inscribed on the banner of the first: Science and Democracy—*in hoc signo vinces!*" Science and democracy—this idea served also as a guide to action for Timiriazev; to him it denoted an organic bond between theory and practice, science actively serving mankind, and plant physiology at the service of agriculture. Timiriazev was a confirmed opponent of all narrow specialization, of the man of science shutting himself up in his laboratory so that there ceases to be a common language between the man of science and the community, and even between one scientific worker and another. But though specialization can be a serious evil it is essential for the development of modern science. With a very wide circle of interests, in his own research Timiriazev limited himself to one field, indeed to one problem. To explain the working of photosynthesis, the effect of solar energy on plants, was his life-work. The problem of photosynthesis was very clearly linked up for Timiriazev with general biology and his world outlook. He held that "the task of the physiologist is not to describe, but to explain and direct nature, his role must not be that of an observer but that of an active experimenter".

Copernicus Commemoration

But for the War, Poland would have commemorated the four hundredth anniversary of the death of Copernicus on May 24, 1543, and the publication of "De Revolutionibus Orbium Coelestium", by an international gathering of astronomers and others interested in the pursuit of natural science. In Great Britain the occasion was marked by a meeting on May 24 at the Royal Institution; the meeting was arranged by the Copernicus Quatercentenary Celebration Committee, a mixed body of distinguished Poles and fellows of the Royal Society, and was attended by the President of Poland and members of the Polish Government in London. The meeting was opened by a short address by Sir Henry Dale, president of the Royal Society, who stressed the significance of Copernicus' contribution to thought, and read a message he had broadcast to a parallel meeting which was being held in New York. Prof. Stanisław Kot, Polish Minister of Information, then delivered an address on Copernicus, surveying the history of Poland during the Middle Ages in order to show the relation of Copernicus to movements of his times, and drawing a picture of university life at Cracow. He remarked that, before the War, books used and annotated by Copernicus were treasured among Polish historical possessions—their fate is unknown.

Prof. Kot was followed by Dr. H. Spencer Jones, Astronomer Royal, who recounted the main facts of the life of Copernicus and dealt in some detail with the significance of the heliocentric theory. Count Edward Raczyński, Polish Ambassador to Great Britain, expressed his country's gratitude for the way in which the Royal Society had assisted in carrying through the limited commemoration which had been possible. The meeting closed with a recorded message from Prof. Harlow Shapley, director of Harvard Observatory, in response to Sir Henry Dale's broadcast address. He spoke from New York, where a commemorative meeting was held in the Carnegie Hall, and mentioned that, in addition to other similar meetings, planetaria in the United States are showing special programmes during May. By such means, Poles in exile and scientific men of the other members of the United Nations joined in commemorating the work of Copernicus as one of the great natural philosophers of all time.

The Science Library, South Kensington

In this War, Mr. Roosevelt has said, books are weapons, and perhaps it has needed an emergency like the present to prove the value of scientific and technical libraries to many who have not hitherto given them much thought, or seen the necessity for their active development and encouragement, if a country is to play a worthy part in the world's activities. Certain it is that to-day Government Departments in Great Britain directly concerned with the war effort—especially new offices without established information centres of their own—are increasingly relying on them for much information needed for the successful prosecution of their work. The Science Library at South Kensington, as one of the largest of these libraries, with its wealth of periodical literature and its well-known bibliographical service, is one of those most able to assist the State and firms working for the Government. Its loan department, which deals with many thousands of volumes a year, is a great asset to Great Britain at any time but never more so than at present, and its possession of much scientific literature from the smaller countries of Europe must be a source of the greatest value to the Allied Governments in London, cut off, for the moment, from their own resources. It cannot be divulged what particular services libraries like the Science Library have rendered to Great Britain and its Allies during the War, but these may well be found to be not unworthy of a chapter in the final history. They will show the need for a better understanding of their potentialities, not only in war-time but also in peace, and for a greater consideration for their permanent upkeep at real efficiency level. For the present, it may be stated that in official circles the services of the Science Library are much appreciated, and they are regarded as indispensable for the conduct of the War.

American Library in Great Britain

THE U.S. Office of War Information announces the formal opening of the American Library, which has been operating for several months as a special reference library at the American Embassy, 1 Grosvenor Square. The Library is designed for American, British and other United Nations officials, agencies, for research institutions, associations, business, and for the Press. As Mr. Winant said: "This operation represents trust in the free mind and a desire that our Allies be informed on our way of thinking in the United States". The director of the Library, Dr. Richard H. Heindel, said: "By force of war circumstances this might be called a 'utility' or 'austerity' library. We have not consumed vital shipping space. Many of the American books and periodicals are not easily available elsewhere. The experience gained in the library will help us when the time comes to rebuild the libraries and intellectual life of the continent". The American Library Association, the Library of Congress, learned societies and many other American associations, and their opposite numbers in Great Britain, have been consulted constantly in building up this modest but potentially important centre and cultural focus.

The Linnean Society of London

AT the anniversary meeting of the Linnean Society held on May 24, Mr. A. D. Cotton, keeper of the Herbarium in the Royal Botanic Gardens, Kew, was elected president in succession to Dr. E. S. Russell. Dr. Russell addressed the meeting on "The Stereotypy of Instinctive Behaviour". In a review of the activities of the Society, the retiring President directed attention to the revision of the by-laws, just completed; to concession in the amount to be paid by fellows of sixty-five and more who wish to compound; to the fruitful work of the Crustacea Committee and the Marine Algæ Committee; to grants-in-aid towards the cost of publication; to work done by a sub-committee appointed to prepare a plan for rearranging the Library; to the great need for more shelving for the books; to the gratifying progress made towards completing a photographic record of the Linnean collections and manuscripts; and to the Society's excellent relations with other societies and scientific bodies.

The first fruit of the work of the Sectional Committees, being a key to the British harvestmen or Opiliones by Mr. T. H. Savory, is ready for the printer, as the first of a series of Linnean Society Fauna Synopses. The Marine Algæ Committee's attention has been chiefly directed to collecting data on the ecology of the Fucaceæ.

The Society has created within itself a new class of members, namely associates, who must be less than thirty years of age and for a yearly subscription of one pound will be admitted to meetings, to the use of the Library and will receive the *Proceedings*. It is thought that there may be many biologists, such as advanced students, whose means do not permit them to apply for fellowship, but to whom membership of the Linnean Society offers advantages, contacts that can ripen into friendships and inspiration.

Message from Chinese Men of Science

PROF. TSENG CHAO-LUN, head of the Department of Chemistry of the National Southwest Associated University, Kunming, China, has sent the following open letter to British scientific men:

"While the introduction of modern science into China dates back to eighty years ago, the real beginnings of scientific research in China came after 1919. On May 4 of that year, students in Peiping (then still called Peking) demonstrated against Japanese agression, and from that incident was evolved the so-called 'May 4th Movement', so important in the cultural as well as the political history of modern China. That movement, which quickly spread all over China, not only rallied the country to the standards of democracy but also promoted the natural sciences as factors in the modernization of China. With this impetus, scientific education and scientific research developed at a rate never dreamed of before. The progress made between 1929 and 1937 was particularly rapid, and constant encouragement was received from scientific workers in the United States and in Europe. Since the outbreak of the Sino-Japanese War in 1937, scientific institutions and scientific men in China have suffered tremendously through the deliberate efforts of the Japanese to destroy Chinese culture. But here in the hinterland of Free China, Chinese men of science have been labouring hard for the last five years in the interest of China and of science.

"Chinese scientific workers owe much to Great Britain for their training. For both democratic ideals and scientific accomplishment, we have always looked to Great Britain for guidance. Now, under the banner of the United Nations, Britain and China are fighting shoulder to shoulder to save democracy for the world; a new era of co-operation between the British and Chinese peoples has begun. Early this year we had the honour of welcoming a cultural mission from the British Council. One of its members is Dr. Joseph Needham, who is now doing most valuable work in our country, and who brought with him a large number of scientific books so much needed by us. Recently, Chinese science students in Britain, with the help of the British Ministry of Information, the British Broadcasting Corporation, the British Council, and other organizations, have started a scheme for sending us science news which includes a weekly broadcast summary of the principal contents of each week's issue of NATURE; recent valuable scientific publications and microfilm copies are being sent, and scientific books are being collected with the view of establishing an adequate Science Library in China. Many British men of science are helping in these efforts. We shall never forget such things, and we hope they will develop into a bigger scheme of co-operation between the scientific men of Great Britain and China".

Chance, Freewill and Necessity

THE twenty-seventh Guthrie Lecture of the Physical Society was delivered on May 18 by Prof. E. T. Whittaker, who took as his subject "Chance, Freewill, and Necessity in the Scientific Conception of the Universe". The lecture was devoted to a study of the association which has been held to exist between the philosophical theory of determinism on one hand, and the scientific view of the world on the other. When a coin is tossed, we say that whether it comes down heads or tails is a matter of 'chance'. This does not mean that there is any real indetermination in the occurrence; but merely that we cannot make a confident prediction, because we do not know the precise velocities of translation and rotation which were communicated to the coin by the thumb of the operator, or the exact mass and figure of the coin, or the density and resistance of the air. If these, and the other relevant data which are unknown to us, are called the 'hidden parameters', then an imaginary person to whom the values of the hidden parameters were correctly known would be able, by aid of the laws of dynamics, to calculate mathematically all the circumstances of the flight and to determine whether the coin would fall heads or tails.

Phenomena of this kind, which are in reality deterministic, although we cannot foretell their outcome because of our lack of information regarding hidden parameters, may be called 'crypto-deterministic'. Wherever the notion of 'chance' occurs in classical physics, it has the crypto-deterministic sense. It is otherwise in the newer atomic physics. The alpha-particles emitted by a small quantity of radium salt may be observed by means of the scintillations they produce on a fluorescent screen, and these scintillations appear at irregular intervals—it is impossible to predict the instant when any particular radium atom will explode. By a quantum-mechanical examination, Prof. Whittaker showed that this phenomenon cannot be crypto-deterministic, but involves a true indetermination. Thus the world is not a closed deterministic system but experiences a continual succession of intrusions or fresh creations. The relation of this to certain ideas in Greek philosophy was discussed, and its bearing on the formulation of the law of causality and on the problem of freewill.

English Scientific Film Association

AN English Scientific Film Association was formed on May 15, at a meeting representative of science and films, convened by the Scientific Films Committee of the Association of Scientific Workers. Mr. Arthur Elton was in the chair. He stated that the new association would be independent and self-governing. An Interim Planning Committee was appointed to frame the constitution and to propose conditions of membership. Contact has already been made with the equivalent Scottish association. The acting secretary is Mr. M. Michaelis, 51 Fitzjohn's Avenue, London, N.W.3. The main aims of the new Association are: to promote the national and international use of the scientific film in order to achieve the widest possible understanding and appreciation of scientific methods and outlook, especially in relation to social progress; and to collect, collate and distribute information on the scientific film, including possibly the formation of a reference library of books and the publication of a journal and pamphlets. The Association will publish comprehensive lists of scientific films graded according to scientific merit. It hopes to establish relations with Government departments, public bodies and other organizations which are in a position to make, use or circulate scientific films. A representative panel of scientific workers, to advise producers of films of all types on scientific matters in connexion with their films and to maintain close contact with the film industry, will be compiled.

The Work of Copernicus

PROF HERBERT DINGLE writes: "Might I correct a small error, for which I am partly responsible, in the report of my address on Copernicus printed in NATURE of May 22? Luther did not 'predict' that Copernicus would overturn astronomy. His words were: 'Der Narr will die ganze Kunst Astronomiae umkehren'; that is, 'The fool *wishes to* overturn the whole science of astronomy'. There is no reason to suppose that Luther thought he would succeed.

Comet Whipple-Fedtke

THIS comet is fading rapidly and on April 13 its magnitude was 8·5. An ephemeris is given for June.

	R.A.	Dec.	ρ	r
June 1·0d.	13h. 12·4m.	+21·1°	1·456	2·097
5	13 15·7	19·6	·523	·137
9	13 19·0	18·2	·593	·177
13	13 22·4	16·7	·664	·218
17	13 26·0	15·4	·738	·258
21	13 29·6	14·1	·813	·299
25	13 33·4	12·8	·891	·340
29	13 37·3	11·5	·969	·381

The Night Sky in June

NEW moon occurs on June 2d. 22h. 33m. U.T. and full moon on June 18d. 05h. 14m. The following conjunctions with the moon will take place: June 1d. 19h., Mercury 1° N.; June 6d. 14h., Jupiter 2° N.; June 7d. 00h., Venus 4° N.; June 26d. 05m., Mars 3° N.; June 30d. 19h., Saturn 3° N.; June 30d. 21h., Mercury 3° N. Occultations are very few during the month and only one is worth noticing: June 16d. 1h. 26·0m., γ Lib. (D). Mercury is stationary on June 4 and attains its greatest elongation west on June 18, and on this date rises at 3h. Venus attains its greatest elongation east on June 28 and sets then at 22h. 40m. Mars is moving northward into the constellation of Pisces and rises at 1h. about the middle of the month but cannot be observed very conveniently. Jupiter sets at 22h. 20m. in the middle of the month and can be seen for only a comparatively short period after sunset. Saturn is in superior conjunction with the sun on June 7 and cannot be observed. Summer Solstice is on June 22d. 07h.

Announcements

THE King has been pleased to command that the Institute of Chemistry shall henceforth be known as "The Royal Institute of Chemistry of Great Britain and Ireland".

THE thirteenth Thomas Young Oration will be delivered before the Physical Society by Prof. F. C. Bartlett on June 4 at 5 p.m., in the lecture theatre of the Science Museum, South Kensington. Prof. Bartlett will speak on "Some Current Problems in Visual Functions and Visual Perception".

THE British Coal Utilization Research Association is arranging an open conference on "The Ultra-fine Structure of Coals and Cokes, with Special Reference to the Application of Modern Physical Methods", to be held at the Royal Institution during June 24–25. Forms of applications to attend, which are issued free of charge, can be obtained from the Conference Secretary, B.C.U.R.A., Rickett Street, West Brompton, London, S.W.6, to whom they should be returned by June 4.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Morphine-like Properties of Diphenylethylamine and Related Compounds

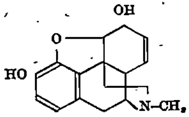
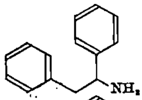
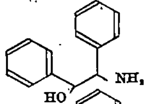
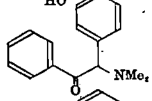
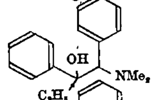
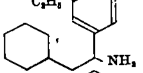
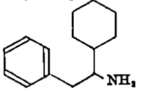
The synthesis of relatively simple stilbene derivatives (stilbœstrol, hexœstrol, etc.) possessing all the physiological properties of the complex naturally-occurring steroid œstrogens[1] has suggested that simple analogues might be prepared to imitate the effects of other complex therapeutically active compounds containing the phenanthrene nucleus. Such a compound is morphine.

A widespread search for a substance possessing the narcotic effects of morphine without its disadvantageous accessory actions has been carried out under the auspices of the American National Committee on Drug Addiction. The substances tested have been mainly morphine derivatives or synthetic phenanthrene or carbazole analogues[2].

We have attempted to find much simpler compounds with morphine-like activity, and this preliminary note reports the results obtained with compounds of the diphenylethylamine series. These substances bear somewhat the same structural resemblance to morphine as do the synthetic œstrogenic analogues to the naturally occurring œstrogens.

In our preliminary tests we have assessed the capacity of the synthetic compounds to: (*a*) depress the righting reflex in rats[3]; (*b*) raise the blood-sugar concentration in rabbits[4]; and (*c*) produce dilatation of the pupil and other effects in cats. Toxicity has in some cases been determined in mice. The substances we have tested possess these activities in varying degrees, and the results obtained with six of the substances which are briefly tabulated below are representative of the larger series which will be published in detail elsewhere.

All the substances have been injected as aqueous solutions of their hydrochlorides. Depression of the righting reflex has been determined after intra-peritoneal injection into at least eight rats. The starved rabbits were injected subcutaneously and blood-sugar determinations were made at hourly intervals for 3 hours after the injection; two or more rabbits were used in each test unless the dose was fatal. Rises in blood-sugar level of less than 20 per cent are not regarded as significant. One or two cats were injected intramuscularly and the figures in the table indicate the number of cats injected and the number of positive responses. The difficulties of supply have so far prevented us using a larger number of animals, which is particularly unfortunate in the case of the cats, in which we find considerable individual variations in response to both morphine and the synthetic compounds. In rabbits and cats that have been used for more than one test there has been a lapse of 7 days or more between successive tests.

		Animal used:	Mice	Rats	Rabbits	Cats		
		Activity tested:	L.D. 50 (mgm./kgm.)	% depression of righting reflex	% max. inc. in blood sugar	Pupil dilatation	Emesis	Hyper-excitability
Substance	Formula	Dose (mgm./kgm.)						
Morphine		2 5 10 20	360	— 5 55 55	6 15 48 121	2/2 2/2 2/2 2/2	1/2 1/2 0/2 0/2	0/2 2/2 2/2 2/2*c*
*M*3 αβ-Diphenyl-ethylamine		10 20 50 100	410	— — 15 85	— 13 72 204+	1/2 1/2 1/1 —	0/2 0/2 0/1 —	2/2 2/2 1/1 —
*M*4 β-Hydroxy-αβ-diphenylethyl-amine		20 50 100	—	— — 0	3 19 16	0/2 2/2 —	0/2 0/2 —	2/2 2/2 —
*M*7 Dimethylamino-benzyl-phenyl-ketone		5 10 20 50	120	— — — 50	— — — 20+	1/2 1/3 — —	0/2 1/3 — —	0/2 0/3 — —
*M*9 β-Hydroxy-αβ-diphenyl-*n*-butyl-dimethylamine		20 50 100	—	— 43+ —	— 17 212+	1/2 — —	0/2 — —	2/2*c* — —
*M*16 α-Phenyl-β-*cyclo*hexyl-ethylamine		10 20 50	275	— 0 86+	55 52 173+	0/1 0/2 —	1/1 1/2 —	1/1 1/2 —
*M*18 α-*cyclo*Hexyl-β-phenyl-ethylamine		20 50	—	21 80	13 103+	0/2 0/1	0/2 1/1	1/2 1/1*c*

c = Convulsions occurred at this dose level. + = One or more animals were killed with this dose.

We have unfortunately not been able to find a satisfactory quantitative test of the analgesic power of morphine or the synthetic compounds in either man or experimental animals. Since this is obviously the crucial test we have conducted rough clinical trials of some of our compounds. *M*3, 4 and 7 have been administered to patients with intractable pain due to pressure symptoms in inoperable cancer. These patients were already under treatment with morphine, and it has been found that all three compounds given orally in doses of 50–400 mgm. every 4 hr. relieved their pain. While these results are by no means quantitative, *M*4 appears to be the most effective, which indicates that the analgesic activity is not related to the capacity to raise the blood sugar.

It is readily admitted that the clinical and experimental data do not justify any claim that these diphenylethylamine compounds can replace morphine. We feel, however, that the results are sufficiently encouraging to warrant publication and the hope that further exploration of the series may yield compounds of much greater activity.

We are grateful to Dr. D. Ranger for clinical trial of the compounds and to Mr. I. A. Hepple for technical assistance.

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[1] Dodds, E. C., Golberg, L., Lawson, W., and Robinson, R., *Proc., Roy. Soc.*, B, **127**, 140 (1939).

[2] Small, L. F., Eddy, N. B., Mosettig, E., and Himmelsbach, C. K., U.S. Public Health Service, Suppl. No. 138, Public Health Reports (1938). National Research Council: Report of Committee on Drug Addiction 1929–1941. Collected reprints 1930–1941.

[3] Eddy, N. B., and Howes, H. A., *J. Pharmacol. Exp. Therap.*, **53**, 430 (1935).

[4] Ross, E. L., *J. Biol. Chem.*, **34**, 335 (1918).

A New Method of Nuclear Methylation of Aromatic Amines and Phenolic Substances

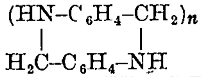
HYDRAZOBENZENE, when heated to high temperatures, decomposes with formation of aniline and azobenzene[1], and it is likely that this reaction starts with the cleavage of an NH–NH linkage forming free radicals, which become stabilized by disproportionation involving undissociated hydrazobenzene:

$$C_6H_5\text{-}NH\text{-}NH\text{-}C_6H_5 \rightarrow 2\,C_6H_5\text{-}NH\text{-}$$
$$2\,C_6H_5\text{-}NH\text{-} + C_6H_5\text{-}NH\text{-}NH\text{-}C_6H_5 = 2\,C_6H_5\text{-}NH_2 + C_6H_5\text{-}N{=}N\text{-}C_6H_5.$$

Hydrocarbons possessing aliphatic C–C linkages also decompose at high temperatures, starting with a cleavage of such a link and formation of radicals, which become stabilized by disproportionation with other undissociated hydrocarbons, thus forming saturated hydrocarbons of smaller carbon content in addition to unsaturated hydrocarbons[2].

$$R\text{-}CH_2\text{-}CH_2\text{-}R \rightarrow 2\,R\text{-}CH_2\text{-}$$
$$2\,R\text{-}CH_2\text{-} + R\text{-}CH_2\text{-}CH_2\text{-}R = 2\,R\text{-}CH_3 + R\text{-}CH{=}CH\text{-}R.$$

Aniline reacts in presence of mineral acids with formaldehyde forming anhydro-4-amino-benzylalcohol, which is a polymer and should possess a ring or long-chain structure of two or more molecules (I or II). In the latter case, the free valencies of the terminal atoms should be saturated by a water (or aniline) molecule.

(I) 

$$\begin{array}{c}(HN\text{-}C_6H_4\text{-}CH_2)_n\\ |\qquad\qquad |\\ H_2C\text{-}C_6H_4\text{-}NH\end{array}$$

(II) $H_2N\text{-}(C_6H_4\text{-}CH_2\text{-}NH)_n\text{-}C_6H_4\text{-}CH_2OH.$

We considered that since this substance contains CH_2–NH linkages which are intermediate between NH–NH and CH_2–CH_2 linkages, they might behave similarly, and form when heated to high temperature in the first place radicals of the type III, $n = 0$, 1, 2 . . . , which in turn would undergo disproportionation with formation of para-toluidine (IV, $n = 0$) or substances (IV, $n = 1, 2 \ldots$), from which para-toluidine could be easily formed during the heating. In this case, some part of the material would be expected to serve as source of hydrogen.

(III) $\text{—HN—}\ (C_6H_4\text{-}CH_2\text{-}NH)_n\text{-}C_6H_4\text{-}CH_2\text{-} \rightarrow$

(IV) $H_2N\text{-}(C_6H_4\text{-}CH_2\text{-}NH)_n\text{-}C_6H_4CH_3 \rightarrow$
$\text{-}HN\text{-}(C_6H_4\text{-}CH_2\text{-}NH)_{n-1}\text{-}C_6H_4\text{-}CH_2\text{-} +$
$CH_3\text{-}C_6H_4\text{-}NH_2.$

Indeed, anhydro-4-amino-benzylalcohol, when heated to a temperature above 300° or simply dry distilled, decomposes with formation of a mixture of almost equal parts of aniline and para-toluidine (total yield, 20 per cent) in addition to small amounts of other products. We have found that the unexpected formation of aniline is due to a side-reaction, namely, the formation of condensation products containing methylene linkages connecting the aromatic groups such as *pp'*-diamino-diphenylmethane and the complicated aniline-formaldehyde resins. These are known to be formed in acidic conditions, and decompose according to our experiments mainly with formation of aniline.

We have, therefore, carried out the distillation in presence of alkaline materials such as calcium hydroxide or sodium carbonate, hoping that under such conditions the side-reaction would be inhibited. We obtained almost pure para-toluidine (yield, 35–40 per cent), the amount of aniline being negligible.

Other anhydro-4-amino-arylalcohols behave similarly[3]. Varying amounts of *pp'*-diamino-diarylmethanes are also obtained. This method is in many cases (*m*-xylidine, *o*-4-xylidine) much superior to any existing methods. The residues of the distillations consist of resinous material which has obviously served as source of hydrogen, but does not lend itself to an investigation.

A more detailed paper will be published elsewhere[3].

Having found that anhydro-4-amino-arylalcohols undergo at high temperatures decomposition with formation of nuclear methylated aromatic amines, we thought it possible that anhydro-2 or 4-hydroxy-aryl-alcohols of the general type I or II (cf. above), which possess oxygen atoms in place of the NH groups of the anhydro-aminoaryl-alcohols, would undergo a similar reaction with the initial formation of radicals and subsequent disproportionation and formation of nuclear methylated phenols; some part of the material would again serve as source of hydrogen.

A study of the literature indicated that the isolation of anhydro-hydroxy-arylalcohols would meet with great difficulties, since *o*- and *p*-hydroxy-arylalcohols, $HO\text{-}Ar\text{-}CH_2OH$, known to be the first reaction products between phenols and formaldehyde in the presence of alkaline catalysts, possess a great tendency in absence or presence of both alkalis and acids to form polyphenolic substances containing methylene linkages between the different phenolic groups, such as the crystalline dihydroxy-diarylmethanes and the more complicated high molecular phenol-formaldehyde resins. The problem of finding conditions, under which anhydro-2- or 4-hydroxy-arylalcohols would be formed, and, in addition, would be sufficiently resistant to the formation of the condensed phenol-formaldehyde products mentioned, at the required high temperature (in excess of 250°), could therefore be expected to be rather complicated.

2.6-Dihydroxymethyl-4-methyl-phenol, $HO\text{–}C_6H_3(CH_2OH)_2CH_3$, was chosen as subject of a detailed investigation. Preliminary experiments showed that, dry distilled, this substance decomposes with the formation of small amounts of 2.4-dimethyl-phenol and 2.4.6-trimethyl-phenol, the two theoretically possible methylated phenols, in addition to a considerable amount of *p*-cresol. The formation of *p*-cresol is due to the intermediate formation of phenol-formaldehyde condensation products consisting of two or more aromatic groups connected by methylene linkages, which, as already shown by Megson[4], and confirmed by us, decompose with formation of the original phenols in addition to traces of methylated phenols (generally less than 2 per cent). This is completely analogous to the formation of aniline from anhydro-4-amino-benzylalcohol owing to the intermediate formation of aniline-formaldehyde resins.

Attempts to heat 2.6-dihydroxymethyl-4-methylphenol in presence of alkaline materials of different strength in the hope of finding conditions which would inhibit the undesired condensation proved to be successful. The amount of methylated phenols varies in presence of different alkaline materials. We have found that alkalis of medium strength such as the hydroxides or oxides of the alkaline earths or the borates of the alkali metals give the best results; yields as high as 25–30 per cent of 2.4.6-trimethylphenol, in addition to some 2.4-dimethyl-phenol, are obtained. The corresponding salts of 2.6-dihydroxymethyl-4-methyl-phenol behave similarly.

The reaction discussed is characteristic for all 2- or 4-hydroxymethyl-phenols and other substances able to form at high temperatures anhydro-2- or 4-hydroxymethyl-phenols; for example, 2- or 4-aminomethyl-phenols, $R_2N\text{–}CH_2\text{–}Ar\text{–}OH$[5].

The bearing of these results on the theory of the formation and structure of phenol-formaldehyde resins and the possibility of making the above results the basis of an economic process for the preparation of nuclear methylated phenols, especially 2.4.6-trimethylphenol, 2.3.5-trimethylphenol, 2.3.5.6-tetramethylphenol, 2.3.4.6-tetramethylphenol, will be discussed in a more detailed paper to be published elsewhere[5].

We thank the Calico Printers' Association, Ltd., Manchester, for permission to publish this letter.

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April 13.

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[1] Hofmann, *Proc. Roy. Soc.*, 12, 576 (1863).

[2] cf. Rice and Rice, "The Aliphatic Free Radicals" (Baltimore, 1935), pp. 91, 142.

[3] cf. in the meantime, Burawoy, *B. Pat.*, 539,747.

[4] *Trans. Far. Soc.*, 32, 336 (1935).

[5] cf. Burawoy, *B. Pat.*, 545,382.

Theory of Large Elastic Deformations

WHEN rubber is subjected to a large elastic deformation, which may be assumed to take place without change of volume, it ceases to be isotropic, and the attempt to relate the stresses and strains in different directions may be a matter of some difficulty. However, if the assumption is made that Hooke's law is obeyed in simple shear in any isotropic plane, it is possible, as Mooney has shown[1], to deduce certain relations which represent the elastic behaviour under the most general type of homogeneous deformation. If such a deformation is defined by the three principal strains, λ_1, λ_2 and λ_3 (where λ_i is the ratio of final to initial length along the i-strain axis), the expression for the work of deformation W is

$$W = \frac{G}{4} \sum_{i=1}^{3} \left(\lambda_i - \frac{1}{\lambda_i}\right)^2 + \frac{H}{4} \sum_{i=1}^{3} \left(\lambda^2 - \frac{1}{\lambda_i^2}\right) \qquad (1).$$

This equation, which rests on an argument of a most general character, leaves two constants G and H to be determined by the specific properties of the material. The constant G may be identified with the ordinary modulus of rigidity, but the physical significance of H is not easy to grasp. The ratio H/G is related to the difference of behaviour under different types of deformation, and is termed by Mooney the "coefficient of asymmetry".

Approaching the subject from a different angle, Wall[2] has recently derived stress-strain relations for an idealized network of molecules, on the basis of the kinetic theory of elasticity. He finds a linear stress-strain relation in shear, and by comparing his equation for elongation with that given by the more general theory of Mooney (equation 1) he is able to relate the constants G and H to a single molecular parameter. The result is

$$G = H = NkT,$$

where N is the effective number of molecules per c.c., k is Boltzmann's constant and T the absolute temperature. Combining this result with equation (1) leads to the simpler form

$$W = \frac{G}{2}\left(\lambda_1^2 + \lambda_2^2 + \lambda_3^2 - 3\right) \quad . \quad . \qquad (2)$$

for the strain energy in the most general type of homogeneous deformation. It follows, therefore, that the description of rubber-like elasticity does not necessarily require the use of two independent physical constants. Whether in fact the behaviour of a given rubber can be satisfactorily represented in terms of a single physical constant is, of course, a matter for experimental investigation.

Our unpublished experiments show that Wall's relations do in fact represent the behaviour of vulcanized rubber in elongation, compression and shear with reasonable accuracy up to moderately large deformations.

If Wall's theory is assumed, then having once used it to derive the simplified form (2) of Mooney's equation, one may proceed to apply this equation to any problem involving the more complex types of deformation of rubber, without further reference to the molecular theory.

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British Rubber Producers'
Research Association, Laboratories,
Welwyn Garden City.
May 5.

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[1] *J. Appl. Phys.*, 11, 582 (1940).

[2] *J. Chem. Phys.*, 10, 485 (1942).

An Application of the Principles of Allometry to the Study of English Senonian Echinocorys

THE following notes summarize the results of an investigation which was curtailed by the War, but which, though incomplete, has introduced some important conceptions. They concern the size and proportion changes in the Senonian sea urchin Echinocorys[1].

APPROXIMATE VALUES OF GROWTH COEFFICIENTS IN SELECTED GROUPS OF ECHINOCORYS

Zone	Subdivision	Locality	Coeffts. of relative height		Coefft. of relative breadth	
			b	a		
M. cortestudinarium		Northfleet	0·21	1·35	0·87	Southern England
M. coranguinum			0·30	1·20	0·83	
Marsupites	*Uintacrinus depressula*		0·27	1·25	0·79	
O. pillula			0·12	1·45	0·83	
Base, *B. mucronata*		Shawford	0·53	1·10	0·84	
Base, *B. mucronata*		Bramford	0·40	1·15	0·86	East Anglia
B. mucronata		Harford	0·33	1·20	0·85	
B. mucronata		Catton	0·32	1·20	0·83	
Ostrea lunata	Sponge beds	Trimingham	0·51	1·05	0·82	
Ostrea lunata	Grey chalk	Trimingham	0·35	1·15	0·85	
Ostrea lunata	White chalk with *O. lunata*	Trimingham	0·20	1·30	0·87	
Holaster planus			0·68	1·05	0·88	Yorkshire
M. cortestudinarium			0·64	1·05	0·89	
Marsupites			0·08	1·50	0·79	
Actinocamax quadratus			0·38	1·15	0·88	

The material was examined in groups, each one from a given horizon and locality, and in each group, breadth and height respectively were plotted against length on a logarithmic grid as described by J. S. Huxley[2].

It was found that breadth was isometric[3] relatively to length, that is, it could be represented by the formula

$$B = b' \times L,$$

where b', in the material examined, varied between approximately 0·8 and 0·9.

Height, on the other hand, was represented by the simple allometry formula

$$H = b \times L^{\alpha},$$

where the coefficient α was greater than unity, that is, height was positively allometric relatively to length, and the coefficient b was smaller than unity, so that the ratio H/L tended to be less than 1.

On the whole, a large value for the coefficient b was accompanied by a small value for the coefficient α, and vice versa. The relationship between the two coefficients is expressed by a formula of the same type as Huxley's simple allometry formula, since the values, if plotted double-logarithmically, form approximately a linear figure.

There is some possibility that the changes in size and proportions can be correlated with changes in environment, that is, depth of water in the Chalk sea, in which case, an increase in size correlated with change of environment appears to give rise in many cases to a *decrease* in relative height, whereas a size increase in the ordinary course of the individual's growth gives rise to an *increase*.

A few sea urchins contemporary with Echinocorys were examined along similar lines, and although the material was scanty there was a suggestion that the coefficient α may be identical in contemporary irregular sea urchins from a given locality. The matter needs further investigation, but its effects on certain taxonomic questions may well be important.

The results are fully described in a thesis accepted by the University of London for the degree of doctor of philosophy, a copy of which thesis is in the University library. JOHN F. HAYWARD.

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[1] See Hayward, J. F., *Naturalist* (1941), for references.

[2] Huxley, J. S., "Problems of Relative Growth" (London, 1932).

[3] Needham, J., and Lerner, I. M., "Terminology of Relative Growth Rates", NATURE, **146**, 618 (1940).

Expediting Visual Adaptation to Darkness

THE problem of expediting artificially the adaptation of the eye to darkness is of considerable theoretical, and of no less practical importance, as, for example, in the case of night flying under war conditions. It has long been established that the period of adaptation when passing into complete darkness from a brilliantly lighted room is 45–50 minutes, and from a dully lighted room 25–30 minutes.

Proceeding from the theory of trophic adaptation of L. A. Orbeli, who demonstrated that the sense organs are innervated by the vegetative nervous system, I formulated the hypothesis that the process of adaptation to darkness is likewise influenced and controlled by the vegetative nervous system. The influence of this system on the visual apparatus (retina, conducting channels and brain centres) may be modified by exciting other sense organs by stimuli adequate to the latter. In 1937 I experimented in expediting adaptation to darkness by exciting the organ of taste (with sugar), the effect of which was to shorten considerably the period of adaptation[1].

Several months ago we experimented in expediting adaptation by means of light muscular exercise, during which the part of a weak exciter of the central nervous system and the visual organ is played by the nerve impulses imparted by the muscles and cartilages as they changed their length and thickness during muscular exercise.

Experiments made on ten subjects with the help of the adaptometer revealed that it was possible in this way to reduce the period of adaptation from 25–45 minutes to 5–6 minutes. Moreover, it was ascertained that usually sensitivity is roughly 20–30 per cent higher after such exercises than after remaining 45 minutes in darkness in a state of rest.

In another series of experiments we measured contrast sensitivity. The experimenter measured the time that elapsed from the moment the subject passed into darkness to the moment he could distinguish a black silhouette against a dark-grey background. Ten to fifteen experiments on eight subjects led us to conclude that this period is reduced to one half or one third under the influence of light muscular exercise.

What is the physiological mechanism of this influence? We believe that we have here a sensory vegetative reflex, as a result of which the functional state of the retina and, in particular, its absolute and contrast sensitivity, are changed. There are grounds for believing that in such cases the vegetative nervous system also affects the periphery (retina) and the visual centres of the cortex and subcortex of the hemispheres. That it is possible to influence the brain through the vegetative nervous system was demonstrated several years ago by A. V. Tonkikh and E. A. Asratyan in Orbeli's laboratory. A. V. Tonkikh showed this in particular in relation to the spinal cord, and E. A. Asratyan in relation to the cortex of the cerebral hemispheres.

Krikor Kekcheyev.

Soviet Scientists' Anti-Fascist Committee,
Moscow. March 19.

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[1] *Bull. Exp. Biol. Med.* (1937).

Science or Pseudo-Science

Recent discussions on the teaching of science recorded in Nature indicate a wide diversity of opinion and a lack of co-ordinated and constructive suggestion. There is the disconcerting prevalence of self-denunciation among the ranks of science teachers themselves—the admission of 'over-specialization', a predilection to use the term 'humanities' with awe, and a *persuasion* that a smattering of the facts of all the sciences, pure and applied, is better than a training in scientific procedure. There is also a hankering after the deliberate training of character in the classroom, for example, by 'humanizing' scientific instruction. Smiles on "Character" pricks this bubble in his first few pages. In brief, there are many who contend that unscientific science (that is, science taught and interpreted in the same way as the humanities as factual knowledge) is more desirable than the science advocated by Armstrong, Huxley and Perry.

The teaching of science cannot be discussed in isolation, but only in relation to the whole of education, much of which is out of school. Those who clamour (I think rightly) for the historical method of teaching science should insist that the historian should teach it. History as now taught is political history. The humanities specialize in inhumanity—instruction in the accumulated evil, intrigue, and strife of the ages. Surely, the time has come when the subject-matter of history should be more stimulating and elevating—the history of the progress of mankind (of art, science, industry). General science should be taught by the historian, *not* by the science master. In the earliest stages English, arithmetic and nature study, if liberally interpreted, provide a complete educational background. Later, nature study gives place to history (including general science and geography).

The Fisher Report (1919) on "The Teaching of English in England" gives an impartial, well-balanced, and searching review of present difficulties in education. Nowhere has the solution of these difficulties been indicated so clearly and convincingly as in this report. Quoting from it:

"Hitherto literature has, even more than science, suffered in the public mind both misunderstanding and degradation. Science has too often been regarded as a kind of skilled labour, a mere handling of materials for profit. Literature has first been confused with the science of language, and then valued for its commercial uses, from the writing of business letters up to the production of saleable books. The word art has been reserved for the more highly coloured or the less seriously valued examples of the latter. We must repeat that a much higher view must be taken of both science and art, and that this view is the only one consistent with a true theory of education. Commercial enterprise may have a legitimate and desirable object in view, but that object cannot claim to be the satisfaction of any of the three great natural affections of the human spirit—the love of truth, the love of beauty, and the love of righteousness."

If English language and literature is made the root and stem of the tree of British education, science can contribute by providing concrete experience for literary and artistic expression. Science is an integration of experience and not of fact. If general science consists of encyclopædic factual knowledge, it is not science, and it cannot be taught as science should be taught. Even special science as now taught in schools is far too much a matter of memory and far too little a matter of experience and scientific development and procedure. The 'specialization' of school science to-day is humanistic specialization—an insistence on much fact and little method. At the university, the student is too often 'lectured into a degree'—the natural consequence of early training.

The humanistic specialization of science arises out of an examination system which is almost exclusively a test of factual knowledge and sheer memory. Science syllabuses should be drastically curtailed so that school science deals with fundamentals so exhaustively as to become part and parcel of the student's mental equipment. His knowledge of science should be similar to his knowledge of running and eating. A written examination is quite inadequate and far too precarious as an educational assessment. Full-time visiting examiners (and advisers) are necessary to assess the work and progress of the pupil and to furnish a detailed record of it.

The primary aim of education should be to create a love of books, a passion for reading, and a desire for knowledge. The pupil must be trained to search for knowledge and to find it. He then educates himself throughout life and stimulates others to do the same. The beginner must not be forcibly fed with classical literature—he must be encouraged to read books that interest him. Any attempt to coerce him is both stupid and dangerous. Post-war houses should be provided with every facility for home education—cupboards, shelving, desks and the equipment for private libraries, studies and laboratories. Education must lead to self-education throughout life. Breadth of vision far transcending anything previously known in education is unlikely but extremely desirable. Small classes, trained and reasonably paid teachers are absolutely essential reforms; also, facilities for adult education—social centres of mental and bodily culture—institutions quite different from a school—halls of leisure).

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April 23.

PHOSPHORUS METABOLISM IN MOULDS

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ONE of the characteristic features of anaerobic carbohydrate metabolism in animal- and yeast-cells is the active participation of a number of well-defined phosphorylated intermediates. Comparatively little, however, is known about the nature and function of phosphorus compounds formed in the course of the aerobic metabolism of living cells. The study of the aerobic phosphorylations is made difficult by the circumstance that even under aerobic conditions fermentation may still occur and account for some of the changes observed in the phosphorus metabolism. In this respect, many mould fungi, especially the species of Aspergillus and Penicillium, occupy a somewhat unique position inasmuch as their carbohydrate metabolism is predominantly aerobic. *Aspergillus niger*, for example, will oxidize sugar very efficiently in the presence of oxygen to non-volatile organic acids such as gluconic, citric and oxalic acid, whereas anaerobically it will scarcely ferment sugar at all.

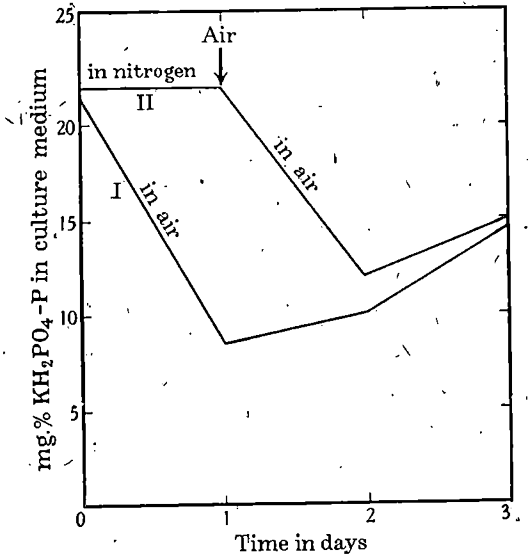
Aspergillus niger culture		Mycelium			Medium (50 ml.)			
Age	Characteristics	Dry weight (gm.)	Phosphorus (mgm.) in the trichloroacetic extract estimated		Glucose (gm.)	Titratable acidity (ml. N acid)	Phosphorus (mgm.) estimated	
			directly	after 7 min. hydrolysis			directly	after ashing
1st day					5·0		17·8	17·8
2 days	Thin continuous mycelium	0·506	0·4	1·6		3·2		
3 days	White strong mycelium	1·056	1·5	5	1·1	15·0	10·5	10·5
5 days	First conidiophores	1·340	1·5	9	0·05	18·0	5·0	5·0
9 days	Mycelium covered with conidiophores	1·728	1·1	12·3	0	5·5	0	0
2 weeks	Autolysis	0·932	2·6	4·8	0	0·3	8·0	9·6

Hitherto, the biochemical investigations of the carbohydrate metabolism in moulds have been chiefly concerned with the many aspects of the formation of the organic acids. These investigations received recently a new stimulus by the discovery that the enzymic oxidation of carbohydrate in moulds appears to be linked with the formation and function of anti-bacterial substances (penicillin A or notatin[1] and penicillin B[2]). Up to the present, however, the metabolism of the acid-producing mould fungi has not been extensively studied with regard to the occurrence and role of phosphorus compounds, although it has been known for some time that inorganic phosphate added to the culture media enhances both the mycelial growth and the formation of acids, and also that moulds are capable of transforming the phosphate into an acid-soluble 'organic' form[3,4].

The experiment recorded in the accompanying table was carried out with *Aspergillus niger* v. *Tiegh* (Nat. Coll. 594) sown on medium composed of 10 per cent glucose, 0·2 per cent potassium phosphate (K_2HPO_4), 0·5 per cent sodium nitrate and 0·1 per cent magnesium sulphate ($MgSO_4.7H_2O$), and grown at 30°. A thin mycelium usually appears 24 hours after sowing and the production of gluconic and citric acid soon follows. At the same time, the absorption of phosphate from the medium begins to be noticeable. The growing mycelium converts a large proportion of the absorbed phosphate into a new compound which can be extracted from the mycelium by means of cold trichloroacetic acid. When hydrolysed for 7 minutes with hydrochloric acid (1N) in boiling water, the phosphorus compound present in the extract breaks down completely to inorganic ortho-phosphate. Thus it behaves like a typical 'easily acid-hydrolysable phosphorus compound'. The use of trichloroacetic acid for extraction is essential. If the mycelium is ground with water instead of trichloroacetic acid, the phosphorus compound is rapidly converted to ortho-phosphate. When, after a week or so of growth, the first conidiophores appear on the mycelium, the medium is almost completely depleted of glucose and phosphate. It contains, however, a large amount of gluconic and citric acid whereas oxalic acid is still absent at this stage; the latter may be found later after the fungus has lived for some time on the two other acids. As soon as the reserve of these two acids has been exhausted, the phosphate reappears once more in the medium, concurrently with the onset of the autolysis, which is indicated by the diminution of the dry weight of the mycelium.

The absorption of phosphate from the medium and the formation of the easily hydrolysable phosphorus compound was found to occur only in the presence of oxygen. Iodoacetate (0·001 N), azide (0·001 N) and fluoride (0·005 N) had a strong inhibitory effect on the respiration and on the acid production of the fungus, and at the same time they brought the phosphorus metabolism to a standstill. They also accelerated the breakdown of the phosphorus compound already existing in the mycelium. These processes could best be studied on mycelia grown directly in the cups of the Barcroft differential manometers. In order to demonstrate the effect of oxygen on the phosphate metabolism, it was found convenient to grow mycelia for several days on media deficient in phosphate (0·01–0·02 per cent instead of 0·2 per cent K_2HPO_4) but otherwise composed as described above. If these mycelia were then transferred to 0·1 per cent phosphate (KH_2PO_4), they quickly utilized the inorganic phosphate and built up from it the easily hydrolysable phosphorus compound provided that oxygen was available (curve I). Otherwise, that is, anaerobically, there was no change in the content of phosphate in the medium (curve II). With the onset of autolysis even in the presence of oxygen, the phosphate uptake declined rapidly. When similar experiments were carried out with pyrophosphate and also with sugar-phosphoric esters, it was found that these were first broken down by the mycelium, and the ortho-phosphate derived from them was built up into the easily hydrolysable compound.

To obtain more definite information with regard to the chemical nature of the new phosphorus compound, several 9-day-old mycelia (dry weight, 20 gm.) were extracted with trichloroacetic acid, the extract treated with an equal volume of alcohol, and filtered. On addition of sodium hydroxide to the clear filtrate, there appeared at pH 5–6 a precipitate, which after drying yielded 700 mgm. of a white powder. This crude preparation was free from orthophosphate but contained 15 per cent easily hydrolysable phosphorus; the curve of acid-hydrolysis closely followed that of pyrophosphoric acid, but the rate of dialysis was slower than that of pyrophosphate proper. At this stage the preparation contained some organically bound nitrogen as well as some carbohydrate which showed reducing property after hydrolysis. However, on further purification by means of precipitations with lead, silver and barium, the phosphorus compound was obtained nitrogen- and carbohydrate-free, but it still contained some organic matter, the ratio C : P not being lower than 1 : 4. From an alkaline solution of a purified preparation (28 per cent P) crystalline sodium pyrophosphate was obtained, but it did not account for the entire easily hydrolysable phosphorus. Presumably, the isolated substance may contain more than one easily hydrolysable polyphosphoric acid. This assumption is further strengthened by the behaviour towards barium nitrate, by means of which two distinct fractions have been obtained, one precipitated at pH 2, and the other at pH 5. Both these fractions yielded ortho-phosphate after 7 minutes hydrolysis but the analysis of the fraction precipitated at pH 2 showed a ratio Ba : P = 1 : 2 as required for a tetraphosphoric acid. In its behaviour towards barium nitrate the mould phosphorus compound resembles the polyphosphoric acid complex which has been shown to occur in yeast[5].



It is too early to say what may be the actual size of the polyphosphoric acid molecule in the mycelium itself. The occurrence of large molecules is made probable by the fact that if the mycelium was ground rapidly with acetone and dried, it retained a high proportion of the easily hydrolysable phosphorus. On the other hand, there is the possibility that the polyphosphate exists in the mycelium in combination with an organic substance and that this complex, though not sensitive to the acetone treatment, is affected by the acid extraction. Finally, it should be mentioned that the formation of polyphosphate is by no means restricted to *Aspergillus niger*. Various moulds, among them *Penicillium notatum* Westling (Fleming), were found to be capable of performing a similar synthesis, the most striking feature of which was its aerobic character.

[1] Coulthard *et. al.*, NATURE, **150**, 634 (1942).
[2] Robert *et. al.*, *J. Biol. Chem.*, **147**, 47 (1943).
[3] Vorbrodt, *Bull. Int. Acad. Pol.*, 1099 (1926).
[4] Michel-Durand, *Bull. Soc. Chim. Biol.*, **20**, 399 (1938).
[5] Umschweif and Gibaylo, *Acta Biol. Exp.*, **11**, 6, 124 (1937).

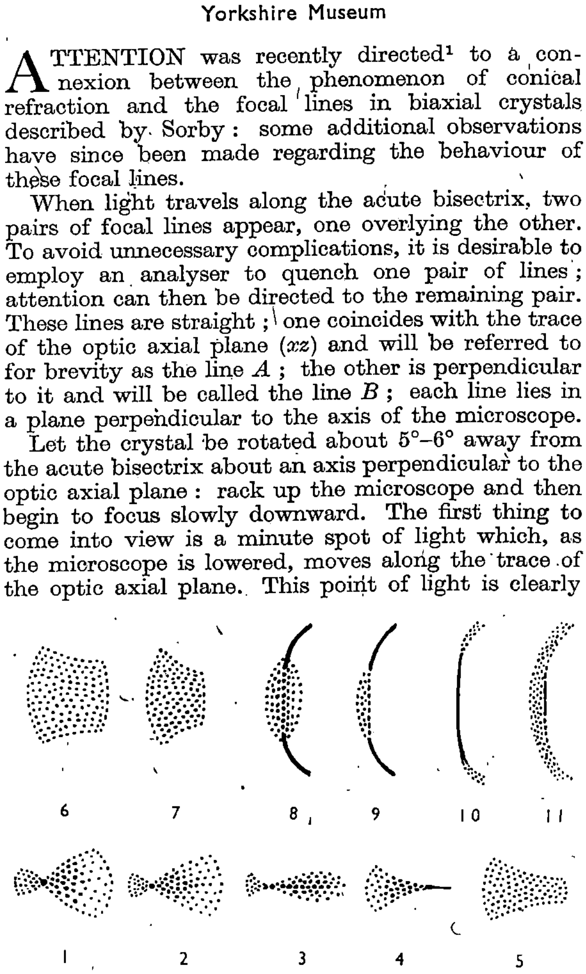
CONICAL REFRACTION

By SIDNEY MELMORE
Yorkshire Museum

ATTENTION was recently directed[1] to a connexion between the phenomenon of conical refraction and the focal lines in biaxial crystals described by Sorby: some additional observations have since been made regarding the behaviour of these focal lines.

When light travels along the acute bisectrix, two pairs of focal lines appear, one overlying the other. To avoid unnecessary complications, it is desirable to employ an analyser to quench one pair of lines; attention can then be directed to the remaining pair. These lines are straight; one coincides with the trace of the optic axial plane (xz) and will be referred to for brevity as the line A; the other is perpendicular to it and will be called the line B; each line lies in a plane perpendicular to the axis of the microscope.

Let the crystal be rotated about 5°–6° away from the acute bisectrix about an axis perpendicular to the optic axial plane: rack up the microscope and then begin to focus slowly downward. The first thing to come into view is a minute spot of light which, as the microscope is lowered, moves along the trace of the optic axial plane. This point of light is clearly a cross-section of the focal line A now running at an acute angle to the axis of the microscope. Continuing to focus downward, two small brushes appear about the point (Fig. 1) and thereafter the successive appearances are as shown in the accompanying figures. The brushes develop into a cusp, after which we pass through an ill-defined region out of which the second focal line B emerges. This line is no longer straight but crescent-shaped and does not lie wholly in one



plane, for the horns of the crescent come into focus a little before the centre.

From serial drawings of this kind it is possible to construct a thread model showing the course of the rays from one focal line to the other. A small perspective representation of it would serve no useful purpose, but the model can easily be made by anyone interested, as follows. On a base-board draw the curved focal line B; drill seventeen holes in it, *a*, *b*, *c* . . . *i* . . . *o*, *p*, *q*, at equal intervals apart, the hole *i* being at the vertex of the curve. Next, on a narrow strip of wood draw a straight line parallel to its length and drill nine holes 1, 2, 3 . . . 7, 8, 9, at equal intervals along the line. Fix this rod at a convenient height above the baseboard so that it lies over the axis of the curve, the end 1 being inclined downward over the concave side. The holes are now to be joined by threads according to the following scheme:

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	8	7	6	5	4	3	2	1

in which the holes in the same column are to be joined. (If the joins to the points in the latter half of the last line are omitted, a better view can be had of the threads in the interior of the model.) Cross-sections of this model by imaginary horizontal planes will be found to reproduce the appearances seen under the microscope.

But to return to the observations themselves. On rotating the crystal into positions such that the refracted rays approach nearer and nearer to the optic axis, and making observations in depth at each position, it is seen that the focal line A (represented by successive positions of the faint spot of light) continues to turn over, until, when the optic axis is reached, it is parallel to the axis of the microscope. We then see that the light giving rise to the Hamiltonian conical refraction does not proceed from a point (as most descriptions of the phenomenon lead one to suppose) but emanates from a focal line: the bright central spot is this focal line seen end on.

Sir George Stokes supplied the mathematical theory underlying the effects observed by Sorby, and after considering the case of rays in the xz-plane he concludes: "The extravagant changes of apparent index in the immediate neighbourhood of the wave- and ray-axes could probably not well be followed by the microscope, on account of the necessity of working with pencils of finite angular aperture, which would make the phenomena of focusing blend themselves with those of conical refraction"[2]. Observation shows that this is true; and that it is also true far away from the neighbourhood of the optic axes; so that it is impossible to draw any but an arbitrary distinction between the Hamiltonian conical refraction in the neighbourhood of the optic axes and that taking place elsewhere in the optic axial plane.

After determining refractive indexes of aragonite to five places of decimals by the prism method, Glazebrook formed the opinion that it is "most probable that Fresnel's theory is only true as a first approximation", and "we may assert that in a central section of the wave-surface inclined at a small angle to the plane of the optic axes, there is a considerable difference between Fresnel's theory and experiment: that the differences between the two are most marked in the neighbourhood of the optic axes, and amount there to 0·0005 about"[3].

It is in this region near the optic axial plane that Sorby's method also indicates departures from Fresnel's wave-surface, for as Stokes noted: "Mr. Sorby's method is remarkable for this, that it brings out into prominence variations of refraction with change of direction, though the absolute refractions which are involved may be nearly the same"[2]. Unfortunately, these differences cannot be determined quantitatively beyond three places of decimals by this method, even when the focal line lies wholly in one plane.

Rays travelling in the yz-plane also form curved focal lines.

The problem of deducing the form of the wave-surface from the shape of the focal lines is evidently a formidable one, for even Stokes, owing to the mathematical difficulties involved, did not deal with such a line throughout its whole length, but only with one point in it, namely its point of intersection with a principal section of the wave-surface.

[1] Melmore, S., Nature, **150**, 382 (1942).

[2] Stokes, G. G., *Proc. Roy. Soc.*, **26**, 386 (1878).

[3] Glazebrook, R. T., *Phil. Trans. Roy. Soc.*, **170**, 287 (1879).

A NEW ELECTRICAL FREQUENCY DIVIDER

One of the common characteristics of all non-linear electrical devices, such as vacuum tubes, is the generation of harmonic frequencies in which, with a pure sine wave input, the output contains a series of multiples of the input frequency. For more than a decade, piezo-electric oscillators have been used as sources of reference frequencies because of their high stability. Since it is desirable to operate these oscillators at a frequency higher than those of the standards—usually at 100 kc.—a sub-multiple generator, or frequency divider, is required to secure the desired lower frequencies.

The most successful frequency dividing circuit is the regenerative frequency divider, the basic form of which is described in an article by F. R. Stan el (*Bell Lab. Rec.*, 21, No. 4; Dec. 1942). It consists of a modulator, an output circuit tuned to the sub-multiple frequency to be produced, and a harmonic generator. The action of the circuit is easy to understand. Assume, for example, that the input frequency is 100 kc., and that the output is 20 kc. Part of the output is fed back to the harmonic generator, where its fourth harmonic, 80 kc., will be selected by a tuned circuit. This 80 kc. current and the 100 kc. input will result in a difference frequency of 20 kc. in the output of the modulator, and in a number of other frequencies as well. The 20 kc. output frequency is selected by the tuned circuit. To start the oscillators, a 20 kc. component must be present in the circuit. In some regenerative frequency dividers this is supplied by a pulse applied from a starting circuit, but in more recent circuits the starting circuit has been omitted and dependence is placed upon the transient voltages normally present in the circuit for this starting pulse.

In general, when the nth sub-multiple frequency is desired, the harmonic generator is tuned to the $(n-1)$th harmonic. When the output frequency is to be half the input frequency, $(n-1)$ is equal to 1, and no harmonic generator is required. Part of the output is fed back directly to the modulator.

The regenerative frequency generator cannot operate without an input frequency. Should the input frequency fail, the output drops to zero, and thus off-frequency operation does not occur. In addition, the output current of the generator is a relatively pure sine wave, and additional 'clean-up' filters are not required as they are with the multivibrator when a sine wave is desired. A pentagrid-mixer tube is used for the modulator and a pentode for the harmonic generator. With a modulator tube having two shielded input grids, it is possible to eliminate the balanced modulators and transformers required for earlier regenerative frequency dividers. With the increased modulator gain obtained, not only is it possible to eliminate the starting circuit, but also frequency division as great as 10 to 1 is obtainable in one stage.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, May 29

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Capt. Helmer Dahl: "Norwegian Universities and Schools—Past, Present and Future".

Monday, May 31

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. F. A. Secrett: "Horticulture in Peace and War".

Friday, June 4

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. F. C. Bartlett, F.R.S.: "Some Current Problems in Visual Functions and Visual Perception" (13th Thomas Young Oration).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Arthur Bryant: "Our Sea Tradition".

Saturday, June 5

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4 p.m.—Prof. J. Yule Bogue: "Applied Photography"; Miss K. C. Clark: "Indirect Radiography as applied to Medical Work"; Dr. L. Mullins: "Miscellaneous Applications of Industrial Radiography"; Mr. C. D. Reyersbach: "Sub-Standard Kine-Photomicrography"; Mr. H. M. Ross: "The Photography of Photo-Elastic Stress Patterns".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ENGINEERING SUBJECTS in the Durham Road Senior Technical and Commercial Institute—The Director of Education, Education Office, Prince Consort Road South, Gateshead (June 3)

RESIDENT LECTURER IN SCIENCE, able to take Gardening—The Principal, Diocesan Training College, Fishponds, Bristol (June 5).

LECTURER TO TEACH ELECTRICAL ENGINEERING SUBJECTS in the Municipal Technical College—The Director of Education, Education Offices, Nelson Square, Bolton (June 5).

PHARMACIST at the County Hospital, Pembury, Tunbridge Wells—The County Medical Officer, County Hall, Maidstone (June 7).

PRINCIPAL of the South-East Essex Technical College, Dagenham—The Chief Education Officer, County Offices, Chelmsford (June 12).

PSYCHIATRIC SOCIAL WORKER to work with the Psychiatrist and Educational Psychologist in the Child Guidance Clinic—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (June 21).

CITY BACTERIOLOGIST—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (June 30).

CHIEF TECHNICAL ASSISTANT, SENIOR TECHNICAL ASSISTANT, and TECHNICAL ASSISTANT I, FOR ENGINEERS experienced in the use of Woodworking Machine Tools or Production Managers experienced in Planning the Production of Machined Woodwork—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1068), Alexandra House, Kingsway, London, W.C.2.

BIOLOGY TEACHER (part-time) to assist in Botany and Zoology—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 9: Salmon and Sea Trout of the Waterville (Currane) River. By Arthur E. J. Went and T. Sankey Barker. Pp. 83–102. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. 6*d*. [124

Report of the Rugby School Natural History Society for the Year 1942. (Seventy-sixth Issue.) Pp. 22. (Rugby: George Over, Ltd.) [124

University of London: University College. Annual Report, February 1942—February 1943. Pp. 64. (London: Taylor and Francis, Ltd.) [124

British Records Association. Memorandum No. 7: Modern Records, What may we Destroy? Pp. 6. (London: British Records Association, c/o Public Record Office.) [134

Report of the Committee on Post-War Agricultural Education in England and Wales. (Cmd. 6433.) Pp. 92. (London: H.M. Stationery Office.) 1*s*. 6*d*. net. [134

The Pre-Nursing Course: Synopsis of Regulations, Suggestions for Syllabuses, Equipment and Books: together with further Recommendations of the Association of Women Science Teachers. Pp. 20. (London: John Murray.) 9*d*. [154

National Institute of Economic and Social Research. Annual Report, 1942. Pp. 12. (London: National Institute of Economic eud Social Research.) [194

Other Countries

Records of the Geological Survey of India. Vol. 77; Professional Paper No. 1: Report on Sodium Salts in *Reh* Soils in the United Provinces, with Notes on Occurrences in other parts of India. By J. B. Auden, B. C. Gupta, P. C. Roy and Mehdi Hussain. Pp. ii+45. (Calcutta: Geological Survey of India.) 14 annas; 1*s*. 3*d*. [124

Indian Forest Records (New Series). Utilisation, Vol. 2, No. 8: The Testing and Suitability of Indian Timbers for Plywood Tea Chests. By V. D. Limaye and Sultan Mohammed. Pp. v+179–190+4 plates. 9 annas; 10*d*. Entomology, Vol. 7, No. 2: On Some Indian Cerambycidae. By J. C. M. Gardner. Pp. ii+66–72. 6 annas; 7*d*. (Delhi: Manager of Publications.) [124

Smithsonian Institution. War Background Studies, No. 9: The Native Peoples of New Guinea. By M. W. Stirling. (Publication 3726.) Pp. vi+25+28 plates. (Washington, D.C.: Smithsonian Institution.) [134

Ministry of Finance, Egypt: Survey of Egypt. Egypt in the Classical Geographers. By the late Dr. John Ball. Pp. vi+185+8 plates. (Cairo: Government Press.) 750 mills. [144

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 94, 1942. Pp. iii+408+27 plates. (Philadelphia: Academy of Natural Sciences of Philadelphia.) 7.50 dollars. [154

Indian Forest Bulletin No. 108: Manufacture of Newsprint, Cheap Papers and Boards. (Interim Report on the Investigations carried out at the Forest Research Institute, Dehra Dun.) By M. P. Bhargava and S. Kartar Singh. Pp. iii+15. (Delhi: Manager of Publications.) 9 annas; 10*d*. [154

Imperial Council of Agricultural Research. Studies on Fruit and Vegetable Products. 1: Canning of Apricots in Baluchistan. By Dr. G. S. Siddappa. Pp. ii+18+1 plate. 1.4 rupees; 2*s*. 2: Drying of Grapes in Baluchistan. By Dr. G. S. Siddappa. Pp. ii+14+1 plate. 12 annas; 1*s*. (Delhi: Manager of Publications.) [154

Bulletin of the American Museum of Natural History. Vol. 80, Art. 12: A Revision of the Rotatorian Genus *Keratella* with Descriptions of Three New Species and Five New Varieties. By Elbert H. Allstrom. Pp. 411–457+plates 35–42. (New York: American Museum of Natural History.) [164

Proceedings of the United States National Museum. Vol. 93, No. 3160: Skeletal Remains with Cultural Associations from the Chicama, Moche and Virú Valleys, Peru. By T. D. Stewart. Pp. 153–186+plates 11–18. Vol. 93, No. 3161: New Marine Mollusks from the Antillean Region. By Harald A. Rehder. Pp. 187–204+plates 19–20. Vol. 93, No. 3163: Osteology of Upper Cretaceous Lizards from Utah with a Description of a New Species. By Charles W. Gilmore. Pp 209–214. (Washington, D.C.: Government Printing Office.) [164

South African Journal of Science. Vol. 39: Being the Report o the Fortieth Annual Meeting of the South African Association for th Advancement of Science, Johannesburg, 1942, 29th June to 1st July Pp. xviii+387. (Johannesburg: South African Association for th Advancement of Science.) 30*s*. net. [164

University of Cape Town. Communications from the School o African Studies, New Series, No. 7: The Bored Stones of Souther Africa, Part 3: South Eastern, Thirstland, Karoo, and Souther Forests Regions. By A. J. H. Godwin. Pp. iii+27. (Cape Town The University.) 2*s*. [16

The National Academy of Peiping during the Period of Year 1937–42. Pp. 14. (Kunming: National Academy of Peiping.) [16

Dominion Observatory. Bulletin No. R27: Report for the Yea ended 31st December 1941. Pp. 2. (Wellington: Governmen Printer.) [19

U.S. National Museum. Bulletin 180: Fishes of the Phœnix an Samoan Islands collected in 1939 during the Expedition of the U.S. *Bushnell*. By Leonard P. Schultz. Pp. x+316+9 plates. (Washingto D.C.: Government Printing Office.) 65 cents. [19

Smithsonian Miscellaneous Collections. Vol. 103, No. 9: Mystac carida, a New Order of Crustacea from Intertidal Beaches in Mass chusetts and Connecticut. By Robert W. Pennak and Donald Zinn. (Publication 3704.) Pp. ii+11+2 plates. (Washington, D.C. Smithsonian Institution.) [19

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PLANNING THE LAND OF GREAT BRITAIN

THE Bill introduced in the House of Commons by the Minister of Town and Country Planning is clearly a minor measure in fulfilment of a promise made by Lord Reith in the House of Lords in 1941 when announcing the Government's acceptance of the interim report of the Uthwatt Committee. Under this Town and Country Planning (Interim Development) Bill, planning control is to be extended to all areas in England and Wales not already subject to control; it will implement the recommendation of the Uthwatt Committee that no building or development should be permitted which is likely to be prejudicial to the programme of reconstruction that has still to be worked out.

While in this Bill, for the first time, England and Wales are visualized as a unit and planning is conceived on a national scale, including London, the measure is scarcely more than negative in character and its scope is limited. Moreover, it must be remembered that, of the half of the nation's land already covered by plans or planning resolutions, only about 6 per cent is under effective planning control. This position is due to the procedure under the existing Planning Acts being all but prohibitive, administratively and financially. The final Uthwatt Report proposed to break this deadlock by providing a solution to the problem of compensation for values disturbed by planning. Until either those recommendations or others designed to achieve the same result are adopted as official policy, the planning of the use of the land will remain an aspiration only. The obstacle presented by the difficulty of compensation is a fact that cannot be set aside or shelved, and until some proposals for dealing with it are adopted in official policy, plans for building and developing a better Britain are meaningless.

The weakness of the Government's present position was well shown in Mr. Ernest Brown's address to the National Housing and Town Planning Council in March. The one difficulty he shirked was the delay of the Government in making these vital decisions, without which neither town nor country planning is possible. Local authorities can make no plans until they and the owners and users of the land know what the principles of control are to be, and how public and private interests are to be reconciled when they come into conflict. Without that, even the emergency building and housing suggested by Mr. Brown is likely to be unsatisfactory and to conflict with the requirements of a national policy.

In housing, as in other fields, no thorough or systematic preparation for post-war developments is possible until the Government has announced its long delayed decisions on the Barlow, Scott and Uthwatt Reports. The machinery is important enough—and a debate in the House of Commons just before Easter showed there is still confusion on that score—but the vital point is that the Government should indicate its broad lines of policy, for these must determine not only the extent and nature of the plans, but also to some extent the nature of the machinery by which the declared policy is to be implemented. Sir William Jowitt's answer gave a reasonably clear outline of the procedure by which reconstruction policy is discussed and made in the War Cabinet, from the departmental level, through the two subcommittees of the War Cabinet, one of Ministers with Sir William Jowitt as chairman, and the other a special Ministerial committee set up to consider and co-ordinate departmental plans for implementing details of the Beveridge Report, to the Cabinet Committee sitting under the Lord President of the Council, which is concerned with major matters of home policy.

The outline suggests that if there is a Minister of Planning, in the sense of one with a final responsibility for the reconstruction projects upon which the Cabinet must decide, he is the Lord President of the Council, Sir John Anderson, and the adequacy of the existing machinery of government for this purpose could be very well defended up to a point. It does not, however, cover those more fundamental issues of the machinery of government in a democratic State, the balance between central, regional and local administration, which are inherent in the planning of a free society.

What is even more vital at the present time is that the machinery should be used to formulate, announce and implement the basic policies. Continued failure in this respect to adduce the proof of preparedness brings the whole present apparatus of government into disrespect to an extent which may even handicap the war effort. This danger can be clearly seen in a broadsheet "Plans for Physical Reconstruction" issued by Political and Economic Planning last December, in which the most important recommendations of the Barlow, Scott and Uthwatt Reports are summarized, the action already taken indicated, the issues still remaining for decision described, and some of the wider implications of the movement for physical planning indicated. A subsequent broadsheet issued in April, "After the Beveridge Report", reviewing some of the chief problems raised by that report, makes a similar valuable contribution to the appraisal of various aspects of Sir William Beveridge's proposals.

The Barlow, Scott and Uthwatt Reports are all concerned with the physical planning of Great Britain, but from different angles, and in effect they all agree that the nation can no longer afford to allow the 'free price and market' mechanism to act as the chief regulator of the uses of the land, the location of industry, and the growth and decay of towns and cities. The market mechanism itself needs to be regulated and overriden, when the public interest requires, by a public planning mechanism which takes into account all the wide considerations of social, economic and strategic policy ignored by the market. While much of this detailed planning must be worked out and decided by local planning authorities, the three reports also agree that major decisions as to the use of land and the location of industry must be taken nationally by some kind of central planning authority, which can fit local planning schemes into a consistent national development plan and co-ordinate the work of all national agencies concerned with particular aspects of the use of land and industrial location.

Such agencies are only instruments for giving effect to those parts of a wider national policy for social and economic development which fall within their sphere of action. However the instruments of control are constructed, there must therefore be, as the Uthwatt Report insists, "means by which the requirements of agriculture, transport, public services and defence, as well as housing, industrial location, town siting and other matters can be given proper weight and considered as a whole". With the nature and structure of this central machinery we need not be further concerned at the moment: obviously it must be designed to afford some solution to that question of private enterprise and public control on which Mr. Herbert Morrison and Sir Percy Harris have spoken trenchantly; and although the structure of the central authority for control of land and town and country planning has been the subject of much controversy, as indeed the three Reports indicate, its structure must be in harmony with that of the main machinery of government established to serve the needs of a democratic State in the post-war world.

Sir William Jowitt has indicated the Government's view of the paramount importance of the fullest measure of direct responsibility, but at the same time a new permanent commission with more limited functions may be attached to the new Ministry, because it would be the most appropriate body in connexion, for example, with the acquisition of development rights, while it might also be charged with the management of property and similar duties. The new Bill will strengthen the powers of local planning authorities and give them much wider and simpler powers for the compulsory acquisition of land. Lord Portal agrees that the number of local planning authorities is excessive and must be reduced, and he is encouraging them to combine to set up joint planning committees covering wide areas. He is also preparing to make available to local authorities the services of expert planning officers with headquarters in convenient centres; but it is not yet clear whether the Government is prepared to accept the Scott Committee's recommendation that the major local planning authorities should be the councils of counties and county boroughs, or a combination of local government units of equivalent importance. Effective planning of urban re-development also requires decision in the 'reconstruction areas' which are to be developed as wholes, while even a rationalized system of local planning units with reinforced powers and clearly defined tasks requires the support of national funds for the development programmes and to overcome the compensation – betterment obstacle.

That is the main reason why decision on policy is at the moment of primary importance, rather than the machinery by which policy is to be executed, and on this very issue the Government is still considering the Uthwatt Report. That report recommends one approach for built-up areas and another for the rest of the land. For existing town areas, strengthening town planning powers to ensure really effective public control of development or re-development is recommended. For land remaining in private ownership, compensation would continue to be paid; but to offset this the Uthwatt Committee suggests that when such land is benefited by public planning, betterment should be recouped by a periodical levy.

If the development rights scheme is adopted, controversy over the proposed basis of compensation appears to be inevitable. Another controversial issue is whether, under the development rights scheme, it would be automatically necessary—as the Uthwatt Committee assumes—to acquire publicly all land needed for approved private development schemes. It may well be wise to postpone as long as possible the consideration of nationalization of the land if our objective can be achieved by more elastic methods under a comprehensive central policy adapted for change with changing conditions. Given also wise control and efficient persons entrusted generously with responsibility for local action, the issue between private and national ownership may become insignificant, as the measure of co-operation secured in such ways by the Ministries of Food and of Agriculture seems to show.

Whatever ultimate decisions are taken on these questions, larger problems loom in the background. The scale and pace of the post-war building have still to be decided, and agricultural housing is not alone in forcing the issue. The Ministry of Works and Planning, which is working on the supply problems involved, must balance housing demands against the demands for other types of constructional development. The whole building programme must then be translated into programmes for the use of land, labour supply and raw materials. Moreover, the physical plan has to be integrated with wider social and economic plans. The total demands of physical reconstruction on Britain's resources require balancing against other conflicting demands—those of the export industries, of agriculture, of the Beveridge plan, of consumers for consumers' goods, and of other countries needing assistance in rehabilitation.

From this angle alone it is essential for the Government to define more clearly its attitude both to the Barlow Report and to the Beveridge Report. Again, policies for national planning of the land, urban redevelopment, balanced regional economic development and redistribution of industry and population, ultimately require provisional national objectives for the balance to be aimed at between urban and rural life, and for the related, but by no means identical, balance between industry and agriculture. Acceptance or rejection of the Scott Committee's plea to make the countryside prosperous solely by maintaining a prosperous agriculture will be determined by the decisions on such issues.

These problems extend far beyond the scope of any single Ministry, and they demand a great deal of creative and constructive thinking and research. A Ministerial Committee working on such problems would almost inevitably grow into the Cabinet's chief organ for framing general social and economic planning policy in its major aspects. Any such development could scarcely fail to make an expert social and economic 'general staff' for planning imperative, the need for which should already be obvious when the most cursory attempt is made to survey the vast range of interdependent problems involved.

ECONOMICS AND POLITICS IN THE SOUTH SEAS

The South Seas in the Modern World
By Prof. Felix M. Keesing. (Institute of Pacific Relations: International Research Series.) Pp. xv+391. (London: George Allen and Unwin, Ltd., 1942.) 16*s*. net.

THIS book, in the author's own words, "attempts to define comprehensively the political, strategic, and economic role" of the South Seas in the world to-day. It is written in the manner of a general introduction for the non-specialist reader to a part of the world on which information is not easily available; but in order to produce it Dr. Keesing has drawn, not only on his own extensive travels, but also on a wide range of literature, including unpublished first-hand accounts, and the specialist too will find in it valuable fresh data.

After an introductory chapter describing the geographical setting of the islands and their internal and external communications, and concluding with a section on recent political developments which has unfortunately become out of date between the publication of the book in the United States and its appearance in Great Britain, Dr. Keesing goes on to discuss their economic potentialities and commercial relations with the outside world. In only three groups, as he points out, does trade with the metropolitan Power form a significant proportion of total trade—in Hawaii, the Japanese mandated area, and the Cook Islands. As significant economic trends in the period since the War of 1914–18 he notes the decrease in the number of white small-holders, the increase in production by native communities and by large-scale enterprises, and the marked growth of economic nationalism.

The short section on population is welcome as a corrective to the mystical ideas about the causes of depopulation in the South Seas that have gained wide currency. Dr. Keesing quotes the observations of field-workers who have tested Rivers' theory that native populations die out from loss of *joie de vivre*, and found it inadequate, and gives the statistics now available which show that in many areas the trend has been reversed.

A description of the characteristic reactions to culture contact leads on to a discussion of "alternatives in native policy", in which the American aim of rapid Westernization is contrasted with the British preference for a more gradual development. This divergence of views may have great significance for the future of the dependent areas in the Pacific, particularly if it is interpreted by American public opinion as a contrast between active trusteeship and neglect. It is of interest to learn from Dr. Keesing that "the wisdom of high-pressure assimilation has been questioned in the last few years". A fuller discussion of this point might have been valuable in a book intended to inform the general public on the problems of the South Seas; but the author could not have foreseen how urgent the question would become.

In discussing government and leadership, Dr. Keesing gives the impression of being hampered by the need to reduce a very complex variety of native political systems, with their corresponding problems of administration, to a few broad generalizations, and he uses phrases which must puzzle the layman and are even hard for the specialist to interpret. Systems of life in Polynesia were "oriented towards localism and warfare". In Samoa a "tendency towards desiccation" has resulted in the splitting of titles and the privileges going with them between numbers of persons, but this has been stopped—how ?—by the American naval authorities.

Dr. Keesing is too kind to the British Colonial Office in coupling it with that of the Netherlands as having "led the way in requiring their administrative staffs to receive special training". In this respect Britain is behind France, Belgium, and her own Dominions.

Land tenure is another subject where it is difficult to describe in generalizations the complex problems arising over this wide area. The point is made, however, that in many dependencies the best land is now in non-native hands, and that the native areas, though apparently extensive, are no longer sufficient where populations are increasing.

In the South Seas the indirect disruption of native economic systems by the drain of young men to centres of employment has probably been less than it has in Africa, but deliberate interference with native usages which are thought by administrative authorities to be wasteful of time or resources has been much greater, and has been, as Dr. Keesing puts it, "a potent source of trouble". He explains the difficulty of inducing native communities to improve their production, in the sense of increasing its cash value, by the fact that "it carries the people concerned beyond what their real wants and tastes dictate". He notes the disorganizing effects that can be produced by a sudden influx of money in an unsophisticated community, and the still greater disorganization that can result when such a community has been persuaded to become dependent on the world price of a single commodity.

The section on health and medical work brings together much interesting and not easily accessible material. The work of the Suva Central Medical School in training native practitioners for work in a number of British and American dependencies, as well as the New Hebrides, is an encouraging example of Anglo-American co-operation. The School was organized by Dr. S. M. Lambert, a representative of the Rockefeller Foundation, and financed jointly by the Foundation and the administrations concerned.

The important part which Christian missions can play in "the stabilization of the changing native life" is emphasized. This involves a thorough knowledge of native institutions and a sympathetic appreciation of their meaning to the native, and Dr. Keesing notes that at the University of Sydney more than seventy missionaries have gone through the same course of training that is given to cadets in the Australian administrative services.

After a section on education there is a tantalizingly short account of the various non-native groups and their problems—Chinese, Japanese, Indians, other migrants and mixed bloods. Dr. Keesing stresses the importance of this last group and their potentialities for constructive leadership, if they are successfully integrated into the community, as well as the dangers of neglect and discrimination against them.

If events have rendered his concluding prophecies out of date, there will be general agreement with Dr. Keesing's insistence that the fullest knowledge of the facts is essential for the solution of the problems of this area, and that specialist investigation should be utilized wherever possible.

LUCY MAIR.

APPLICATIONS OF ELEMENTARY MATHEMATICS

A Source Book of Mathematical Applications

Compiled by a Committee of the National Council of Teachers of Mathematics. (National Council of Teachers of Mathematics, Seventeenth Yearbook.) Pp. xvi+291. (New York: Teachers College, Columbia University, 1942.) 2 dollars.

THE object of this book is perhaps best explained by a few quotations from the introduction. "To see how a principle is applied is to acquire better understanding of its meaning. To know that a principle can be used enhances the value of learning it. Teachers endeavor to make the study of mathematics meaningful and fruitful by exhibiting this utility. . . . No teacher can hope to be cognizant of all the ways in which mathematics is being used, or to know where to find them. To meet the need for a broader knowledge of direct application this volume has been prepared. . . ."

The book is divided into four sections: arithmetic, algebra, geometry, trigonometry; it covers secondary school mathematics up to and beyond school certificate stage. Each section is divided into sub-sections according to mathematical topic, and in the sub-section the order is that of the field of human activity. Alphabetical arrangement of topics corresponds to a decimal numeration of the entries. The book is intended for reference, rather than for continuous reading, so that an extensive index is provided. Reference here is to the section and number of the entry, but in the page heading neither the section nor (even the leading figure of) the number appear, so that one must glance at the body of the page to see, first that one is in the correct section, and then whether to turn forward or backward. One does, however, soon become familiar with the layout and able quickly to find one's way about.

The entries are very uneven—as the compilers frankly realize. Practically every relevant contribution received has been used, and mostly as supplied. We thus get in some cases little more than vaguely descriptive suggestions, but in others a wealth of numerical or graphical data and sample problems making use of it. Mostly, however, information is supplied and the construction of class exercises is left to the teacher. Teachers in search of realism will be very grateful for the compilation.

One is tempted to use the index to discover where mathematics impinges most on real life. The topics occupying most space in the index are, in order: daily life (a very miscellaneous category), aviation, automobiles, engineering (special technical engineering applications are omitted, as this field is covered in a previous volume), mechanics tieing with astronomy; agriculture comes next, with but half the space devoted to astronomy, while business and finance occupy little space. If this distribution of topic does not indicate any marked difference between American and British interests and ways of life, there is a pronounced American flavour about many of the entries and the language in which they are described. There are some curiosities among the applications, while others raise queries not always mathematical.

Running down the index, one soon encounters: "Beauty Culture—*see* Cosmetology". Following instructions, one is directed to T 7·01, meaning problem 1 in subsection 7 (sine curves) of trigonometry. Here one finds an excerpt from the *American Hairdresser* and one reads (no, *not* a Fourier analysis of a permanent wave, but) a disquisition, illustrated with squiggly diagrams, upon the stimulating effects of 'oscillating' (a distinction is drawn between 'oscillating' and 'alternating') electric currents as affected by differing wave form. A well-known approximate formula for the perimeter of an ellipse is "used by permission of the Chevrolet Division of General Motors Corporation", who use it to find the perimeter of the section of a gear lever. Why? A1 1·19 gives a formula by which the day of the week corresponding to any date may be determined. On p. 297 is an elegant "Sketch showing Principles of Installing Traffiscope on Hill"—whereby a motorist can see the road for some 1,000 ft. beyond the summit. Are Traffiscopes common in the United States? And so on—but the bulk of the book is straightforward, useful and usable material for the teacher of mathematics.

W. G. Bickley.

PROGRESS OF ARMY MEDICINE

War and Disease

By Dr. Ralph H. Major. (Advancement of Science Series, No. 3.) Pp. 190+8 plates. (London: Hutchinson's Scientific and Technical Publications, n.d.) 12*s*. 6*d*. net.

WAR has always been more interesting than disease to the historian, and medical matters received little attention in early chronicles unless hey had a very definite bearing on the outcome of the struggle. Medical men have always followed armies but often for educational rather than humanitarian purposes, and only comparatively recently have organized military medical services been evolved.

Dr. Major has outlined the progress of army medicine from the earliest times to the present day, ccording as he goes the influence of disease on ndividual campaigns and on history in general. Plague and typhus were rife in Greece, and particularly in Athens, in the Peloponnesian War between parta and Athens. In the second century A.D. Roman soldiers who had fought the Parthians mported smallpox from Mesopotamia, and this epidemic, which lasted fifteen years, spread through Italy and the Roman Empire, and may have contributed to the downfall of the Romans. The Crusaders, whose habits and morals were generally ower than readers of Scott would imagine, suffered rom scurvy, and were responsible for an increase in eprosy in Europe. One fine thing did emerge from he Crusades, namely, the foundation of the Knights f St. John or Hospitallers, and the growth of the order and its work is fully described. Briefly covered re the early years of spread of the plague of syphilis, and the part played by the mercenary armies of Charles VIII of France.

The gunpowder era brought new types of wounds and new techniques to deal with them. The pioneers mentioned include Hans von Gerssdorf, Paracelsus, Paré, and Giovanni di Vigo, who was also noted as an early user of mercury in the treatment of syphilis.

Throughout history the same diseases keep recurring: smallpox, plague, typhus, and, since 1492, syphilis. In more recent times, plague forced Napoleon to give up his siege at St. John of Acre and may have altered the shape of history.

The work of Larrey, Napoleon's surgeon, is fully covered, for he can be considered as the forerunner of the modern army surgeon. Larrey was responsible for some excellent observations on trachoma which affected the French armies in Egypt, and for the introduction of ambulances for speedy evacuation of wounded. He had to deal also with scurvy, for the protective effect of lemons, described in 1753 and generally adopted in the British Navy some forty years later, was not yet known to him.

So far there has been little description of any humanizing elements in war and disease, but the Crimean War produced Florence Nightingale, who revolutionized nursing. She reduced the mortality in the hospitals in Scutari from 427 per thousand to 22 per thousand in a few months. In her time the mortality among soldiers in peace-time was twice that of the civilian population, and she was responsible for many reforms in the Army Medical Services. In her footsteps came J. Henry Dunant, an eyewitness of the Battle of Solferino, whose experiences there led him to the formation of the Red Cross Society in 1863.

The Spanish-American War receives full attention both in its political and in its medical aspects, with due importance given to yellow fever and its investigation by Reed and others. The investigation and control of typhoid fever is traced from the Spanish-American War through the Boer War to the present time. Japanese methods and thoroughness are shown in the re-organization of their army medical services after the Chinese War of 1894 when disease caused four times as many deaths as did wounds, so that the proportions were reversed in the Russian War only a few years later.

In the War of 1914–18 the main points studied were the reduction in the rate and mortality in typhoid, influenza, venereal disease, gas gangrene, and tetanus, and the improvements in artificial limbs and plastic surgery. Shellshock brought the psychiatrist to the fore. One of every five men invalided out of the Army passed through the hands of the psychiatrist. The proportion is as great to-day. Perhaps the wars of the future may be fought bloodlessly by an exchange of psychiatrists. The Italo-Abyssinian War was conspicuous by the absence of scurvy and louse-borne diseases from the large Italian Armies, although both were rife on the Abyssinian side. The Spanish Civil War was the testing ground for the Winnett-Orr technique in wound surgery. Sulphonamide therapy is the only subject covered in the present War.

This book is an excellent short survey of the subject and does not suffer by the author's occasional digressions into local politics. That its reading is none too easy is the fault of war-time conditions of small type and restricted space, and this, too, has no doubt reduced the number of possible illustrations which could have enhanced the interest.

J. Marshall.

RECENT ADVANCES IN THE THEORY OF THE FUNDAMENTAL PARTICLES OF PHYSICS

By Prof. R. H. FOWLER, O.B.E., F.R.S.

AT the meeting during January 2–4 in Calcutta of the Indian Science Congress, Dr. H. J. Bhabha was president of the Section of Physics. His presidential address on the theory of the "Fundamental Particles of Physics", to which he has himself made important contributions, has recently been received in Great Britain.

Dr. Bhabha starts by reviewing the manner in which the basic concepts of physics have been generalized from those of the nineteenth century, first by the incorporation of the unified space-time of the theory of relativity and then of the requirements of the quantum theory. This process of incorporation is still incomplete, but significant progress has been made, about which Bhabha's address contains, as one would expect, much interesting comment.

Bhabha starts by reminding us of the fact—which we all know but sometimes forget—that, when the recognition of new facts of observation requires the use of wider postulates than heretofore as the basic postulates of physics, the generalized theory is inevitably more, not less, exacting in its demands on the fundamental equations of physics. The generalization results in *less*, not more, freedom of choice of quantities that the theory determines *a priori*. For example, the special theory of relativity requires the fundamental equations of physics to be invariant for the transformations of the Lorentz group, whereas in Newtonian physics the laws need only be invariant for all transformations of the three-dimensional space-rotation group, which is a sub-group of the Lorentz group. It is important to realize that it is just this generalization which eliminates much arbitrariness from Newtonian physics. In Newtonian theory, the interaction between two particles can be chosen entirely arbitrarily and only determined empirically by observation. In the relativistic generalization, the interaction can no longer be given by an arbitrary static function, for such a specification would not be invariant for the extended Lorentz group of transformations. In relativistic theory the interaction between two particles at a distance must be carried by the medium of a field, and the field functions, u, of this field *must* satisfy the generalized wave equation

$$\frac{\partial^2 u}{c\partial t^2} - \frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial y^2} - \frac{\partial^2 u}{\partial z^2} + \chi^2 u = 0,$$

in which χ is an invariant which may be zero. The assertion "must satisfy" above is strictly an overstatement of the logical position. The u-equation given is the *simplest* possible invariant differential equation which u can satisfy and perform its required functions. There are, however, more complicated equations of higher order which u might satisfy alternatively, but these can still rightly be ruled out on grounds of less simplicity, until by exhaustive study it has been found that the observed facts demand the greater complication. For the present we are not so faced, and may provisionally conclude that relativistic invariance restricts us (in the static case) to a variation of the potential energy of interaction of two particles, a distance r apart of the form

$$\frac{e^{-\chi r}}{r},$$

or a combination of this function and its spac derivatives.

The requirements of the generalization of classica mechanics to cover the quantum theory add to thes relativistic restrictions an entirely distinct set o additional restrictions; the combined effect o relativity plus quantum theory is so stringent tha one can formulate precisely all the theories that ar possible in conformity with both generalizations, an Bhabha describes in his address the various arguments and stages in this notable development, pointing out where the formulation is still inadequate An important point established even by an incomplete formulation of relativistic quantum theory i that a one-particle theory is impossible. Even if on starts with one particle, there is always the possibilit that the number can be increased by pair creation Recognizing this, one sets out with the objective o a many-particle theory, in which the number o particles is not conserved. Such a theory require the use of *two* tensors at least: (i) an energy-momentum tensor ∂, one component of which gives th energy density of the particles at any point of space-time; and (ii) a charge-current tensor, one component of which gives the charge density at an point of space-time. Such a theory can be formulated but for particles of half odd-integral spin the tota energy is not necessarily positive. This is th generalized form of the difficulty first met with b Dirac in his relativistic theory of the electron. I can be satisfactorily turned in the same way as i Dirac's theory, if the particles obey the Fermi-Dira statistics, and a vacuum corresponds to condition in which the negative energy states are all full. On concludes that *a physically sensible theory of particle of half odd-integral spin* ($\frac{1}{2}\hbar$, $\frac{3}{2}\hbar$, $\frac{5}{2}\hbar$, ...) *is onl possible if the particles obey the Fermi-Dirac statistics* Somewhat similar arguments first completed b Pauli and Fierz enable one to conclude that *a physically sensible theory of particles of integral spin* ($\hbar$, $2\hbar$ $3\hbar$, . . .) *is only possible if the particles obey th Einstein-Bose statistics.*

These conclusions as to the relation between spi and statistics of possible fundamental particles ar stressed by Bhabha as a remarkable example of ho widening the basic concepts of a theory, as here b the unification of relativity and quantum theory, lead to a drastic reduction in the outstanding arbitrarines in the theory and to a consequent advance in ou understanding of the basic properties of the fundamental particles of physics.

The address next describes recent progress tha has been made in eliminating infinities and divergen results from the relativistic (non-quantum) theory o the point electron. It has been realized recently (th first indication was the discovery of the neutron) tha the finite inertial mass of a moving charge need not and in fact can not, be tied on its non-zero size a in Lorentz's theory of the electron. It is best at th present stage to regard mass as a constant of fundamental particle not determined by the relativistic quantum theory formulation, of the dept discussed in this address, and to abandon any attemp to assign a structure to a fundamental particle. Th problem then arises of developing a satisfactory infinity-free theory of a structureless point-particle reacting with a radiation field. Much progress ha already been made with the problem. Dirac and Pryce have shown that such a relativistic classical theory of a point electron is possible, taking into account exactly its interaction with the field of electro-magnetic radiation. This success has been extended by Bhabha himself to particles with charge, spin and dipoles, and to such particles moving also in 'meson' fields—that is, fields of the type that arise when the particles interact with each other by continual creation and reabsorption of mesons or heavy electrons of either sign, as appears to be the habit of protons and neutrons. The development of this exact classical theory appears to be a step of great importance, although it has not yet been successfully incorporated in the quantum theory. It is, of course, possible that the extended formulation necessary for this step is so profound that it will turn out to require the fixing of the at present arbitrary inertial masses and dipole strengths attributed to the fundamental particles, which survive in the present exact classical theory—perhaps somewhat after the manner of Eddington's generalized theory. This is a problem for the future: discussion of Eddington's generalizations lies outside the range covered by Bhabha's address.

The programme for the formulation of a relativistic quantum theory contemplated in Bhabha's address is, as we have seen, as yet incompleted and perhaps incompletable. None the less, it is of great interest to pause a moment and consider what sort of world of fundamental particles it could provide us with, and how they would satisfy the requirements of observation. We shall give full weight to all considerations of maximum allowable simplicity, such as assuming that the fundamental particles only have charges $\pm e$ or zero, and no electric dipole moment in a co-ordinate system in which they are at rest, and that particles of unobserved type do not exist unless, of course, their existence follows theoretically from the existence of particles of a type required by observation. On this basis the completed programme would provide us with a set of light 'point' particles—electrons, positrons and neutrinos with charges $-e$, $+e$ and 0 respectively, all with spin $\frac{1}{2}\hbar$ and obeying the Fermi-Dirac statistics. The electron and positrons have identical masses and magnetic dipole moments, but the actual values are not fixed by the programme, nor are the mass and dipole moment of the neutrino, which may differ from those of the electron. The mass of the neutrino is required by observation to be very small compared with that of the electron, and may well be zero. The light particles interact with each other through their electromagnetic fields.

The programme provides us also with a set of heavy 'point' particles—protons (negative protons) and neutrinos of charges e, $-e$ and 0, spin $\frac{1}{2}\hbar$ and obeying the Fermi-Dirac statistics. The protons and negative protons have identical masses and magnetic dipole moments, but the actual values are not fixed by the programme, nor are the mass and dipole moment of the neutron, which may (and in fact do) differ from those of the proton. One would not expect to have observed negative protons. The heavy particles interact with each other through both electromagnetic and meson fields.

The programme also provides us with a set or sets of intermediate particles or mesons, the creation and annihilation of which provide the essential meson field mentioned above. Mesons of charge $\pm e$ and a mass about 170 times that of the electron will provide a meson field of essentially the correct characteristics. Such particles can be unstable and capable of spontaneous conversion into a light electron and neutrino. Such instability is required to account for natural β-ray radioactive decay and for the properties of free mesons as observed in the cosmic rays. Further details are as yet scarcely clear.

The fundamental particles of the programme are thus a rather numerous family of a structure not so simple as the purist might desire before attaching to his satisfaction the label *fundamental*. None the less, such a synthesis or enumeration when completed would represent a magnificent advance, not only for the parts of the theory that it tidies up, but also for the untidy ends lying about which it emphasizes—the undetermined inertial masses and magnetic dipole moments with their rather surprisingly queer ratios. It is here that this programme, which one might describe as the classical relativistic-quantal programme, appears to have reached the bounds of its foreseeable development. One may reasonably expect that further progress will require profound reformulation—proceeding possibly, as suggested above, along paths already indicated by Eddington.

NATIONAL FLOUR AND BREAD

THIRD REPORT

From the Scientific Adviser's Division, Ministry of Food

The first and second reports[1,2] covered the analyses of 622 samples of flour and 459 samples of commercial bread received up to early October 1942. The present report deals with a further 379 samples of flour and 381 samples of bread received in the period ending May 8, 1943.

Quality of Flour

In the period under review, certain changes have been made in the composition of National flour. There has been an increase in the percentage of home-grown wheat used, which at present averages 43·6 per cent. Since mid-March the addition of 2 lb. of skim milk powder per sack has been general (90–95 per cent of the flour is now so fortified) while from February 13, barley or a mixture of groats (dehulled oats) and barley has formed part of the grist.

In May 1942, a start was made on the addition of calcium carbonate (in the form of creta præparata) to flour at the rate of 7 oz. per sack, and at the end of April 1943, approximately 89 per cent of the National flour produced in the United Kingdom was so fortified.

Fibre and B_1. The following table shows the different levels of fibre and B_1 over the 379 samples of flour.

Fibre		B_1	
Value per cent	Per cent of Samples	I.U./gm.	Per cent of Samples
$\leqslant 0{\cdot}4$	9·8	$\geqslant 1{\cdot}20$	4·5
0·5	33·8	1·10	23·0
0·55	49·6	1·05	40·1
0·6	61·5	1·00	67·8
0·7	84·5	0·90	92·4
0·8	93·1	0·80	98·0
0·9	97·8		

A correction has been made in the fibre figures to allow for the addition of any Canadian G.R. flour.

The 'national average' figures for fibre and B_1 are now approximately 0·55 per cent and 1·00–1·05 I.U./gm. respectively. The corresponding figures for the period March–October 1942 were 0·7 per cent and 1·05–1·10 I.U./gm.[2]; there has thus been an appreciable reduction in the fibre content and a slight fall in the B_1 content.

The reduction in fibre is due to new methods of milling (foreshadowed in the second report) and represents a definite improvement in the quality and digestibility of the flour[3].

The very slight fall in B_1 is due to the higher percentage of home-grown wheat used and the lower bran content of the flour (as shown by the fibre figures).

The extractions from any added barley and groats have been fixed for the present at 70 and 85 per cent respectively. Laboratory milling tests have shown that at these extractions, the dilution will have no significant effect on the fibre and B_1 of the finished National flour. This has been confirmed by close analysis of the fibre figures of commercial flours received since February 13.

Protein and Riboflavin. The protein content largely depends, of course, on the composition of the grist. The following figures show this :

Grist	Protein content ($N \times 5·7$) of National flour Per cent
50 per cent Manitoba No. 1 ; 30 per cent Manitoba No. 2 ; 10 per cent Plate ; 10 per cent English ..	13·2
70 per cent Manitoba No. 1 ; 30 per cent English	12·3
All English (2 parts red and 1 part white) ..	8·3

Twenty-two samples of flour taken at random from those received in the period February 12, 1943, to April 4, 1943, and covering large and small mills over the country were examined for protein with the following results :

	Range	Average
Protein	10·7–12·0 per cent	11·3 per cent
Riboflavin	1·4–1·9 μgm./gm.	1·5 μgm./gm.
Fibre	0·25–0·75 per cent	0·50 per cent
B_1	0·8–1·10 I.U./gm.	1·00 I.U./gm.

The average figure of 11·3 per cent is consistent with about 50 per cent English wheat in the grist. The opportunity was also taken to obtain an average figure for the riboflavin content of National flour. Figures are also given for the fibre and B_1 for these 22 samples of flour.

Granularity. Not only the amount but also the size of the bran particles continues to diminish and the following table gives a summary of all the samples examined to date. In every case, correction has been made for any added Canadian G.R. flour :

Sample Nos.	Dates of Examination	Total per cent over 5 silk	Total per cent over 8 silk
1–100/42	1.1.42–19.3.42	11·9	15·0
101–200/42	–16.5.42	10·5	14·9
201–300/42	– 5.7.42	9·3	14·2
301–400/42	–28.8.42	8·4	13·0
401–500/42	–16.10.42	5·5	9·9
501–600/42	–17.12.42	3·8	7·7
601–636/42	–31.12.42	3·5	7·7
1–100/43	–16.2.43	2·4	6·5
101–200/43	– 9.4.43	2·2	6·2
201–250/43	– 6.5.43	1·9	5·8

Aperture No. 5 silk = 0.270 mm. ; Aperture No. 8 silk = 0·190 mm.

Conversion Factor, Flour-Bread. Working at the optimum absorption, one sack of 280 lb. of National flour will yield approximately 380 lb. of bread (190 loaves of 2 lb. each), that is, 1 lb. of flour gives 1·36 lb. of bread. Many bakers use up to 1 gallon of water per sack less than the optimum, so that the average figure is probably near enough to 1·34.

Quality of Bread

A report was published recently[4] on the effects on bread quality of the addition of barley and groats to National flour. Both cereals tend to pull down the quality of the bread if present in large amounts. Two standards of bread quality were considered :

1st standard = best quality commercial bread being made in December 1942.
2nd ,, = satisfactory commercial bread.

Using these two standards, the following are roughly the limits of dilution for each diluent, added separately :

	1st standard	2nd standard
Barley		
Hand-baking	6–8 per cent	15 per cent
Machine-baking	5	10
Groats		
Hand-baking	3	6
Machine-baking	2	5

10 per cent barley, for example, gives a loaf smaller in volume with a somewhat harsher crumb of duller colour.

Increasing the percentage of home-grown wheat used will also lower the loaf quality as judged by the baker. The addition of creta præparata and skim milk powder has had no effect on the baking quality of National flour.

The following is a summary of the quality of the 381 commercial samples of bread received from different parts of the country since the second report was written. In brackets are the corresponding percentages for the previous 459 samples of bread examined :

Quality	No. of loaves	Percentage
Good	112	29 (61)
Fair—good	99	26 (22)
Fair	117	31 (13)
Poor	53	14 (5)

It is evident that there has been a fall in the loaf quality of the bread being sold, although nutritionally it has improved. The fall, however, is not greater than what might be expected because the period during which samples were taken covered that when bakers were not accustomed to the new type of flour, which included a high percentage of home-grown wheat and a proportion of barley and/or groats. Both these factors would lower the tolerance of the flour to variations in baking conditions.

The experimental work in this report was carried out in the Laboratories of the Research Association of British Flour Millers, St. Albans.

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[1] and [2] NATURE, **149**, 460 (1942) ; **150**, 538 (1942).

[3] Moran, T., and Pace, J., NATURE, **150**, 224 (1942).

[4] Technical Baking Panel, Ministry of Food ; Milling and Baking Press, (April 2, 1943).

VISUAL PURPLE

By PROF. RAGNAR GRANIT

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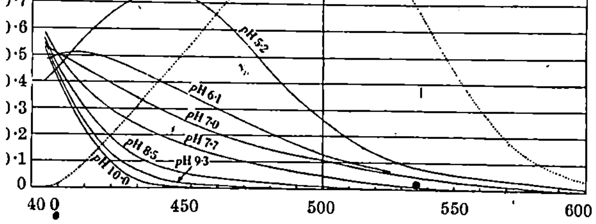
WHEN the late Dr. R. J. Lythgoe, of University College, London, about 1935, took up research on visual purple—the photosensitive substance of the retinal rods—our knowledge in this field had advanced but little since the beginning of this century. To a large extent his own precise and well-planned work, partly carried out in fruitful collaboration with Dr. C. F. Goodeve as an expert on photochemistry, is responsible for the clarity that now makes it possible to write about this subject with feelings of satisfaction. As very few British physiologists have taken an active experimental interest in the subject of vision, the work of Lythgoe has not received the recognition that it deserves, and so, perhaps, it is fitting that an appreciation should come from a colleague abroad. Though all Lythgoe's contributions to the problems of sight were stamped with the same hall-mark of quality, no better tribute can be paid to his memory than to indicate in a brief review the place and significance of his work on visual purple against the background of past and present contributions to the same subject—one particularly dear to him. I can only quote a selected number of papers in the list of references. From these papers and an earlier review (Granit, *Documenta Ophthalm.*, 1, 7; 1938) those interested in the subject will easily find the rest of the references. Lythgoe's own summary (*Brit. J. Ophthalm.*, 24, 21; 1940) is of particular interest as a final statement of his matured views on the subjects of visual purple and dark adaptation.

The old work of König (1894) and his pupils and that of Trendelenburg (1904) had already suggested rather definitely that the human scotopic luminosity curve, which pictures the spectral distribution of sensitivity of the dark-adapted (scotopic) eye, was determined by the spectral absorption curve of visual purple. But the precise form of this absorption curve was still the subject of discussion. Kühne had shown about 1880 that visual purple was bleached by light to a yellow photoproduct (visual yellow) and, if he was right, as others afterwards denied, the yellow substance could be expected to interfere with the measurements of visual purple absorption at the shorter wave-lengths. However, the most recent evidence (Nakashima, 1929, Hosoya, 1935, Chase, 1936) supported Kühne's view and indicated that the cause of older differences of opinion lay in the varying degrees of acidity of the solutions.

Clearly it was necessary to study the spectral absorption curves for visual purple extracts of a very high degree of purity and to follow up this work by analysing the absorptive properties of the various photoproducts found in the course of the bleaching of solutions containing this extremely light-sensitive substance. With characteristic thoroughness and technical perfection Lythgoe embarked upon this programme of research. In the accompanying figure is shown Lythgoe's (1937) absorption curve for visual purple with its maximum at 0·502 μ. Illumination destroys this substance, leading to formation of a photoproduct (left in illustration) that shifts its spectral locus with the degree of acidity of the solution, being yellow in moderately acid solutions and colourless in alkaline solutions, because its maximum is then in the invisible ultra-violet. For this reason Lythgoe called this photoproduct "indicator yellow". This substance is very insensitive to light, and can scarcely play a part in perception except as a filter. This work was soon confirmed by others (Saito, 1938, Chase, 1938, Wald, 1938) but has never been surpassed in accuracy. Krause and Sidwell (1938) have followed the changes farther out into the ultra-violet region.



Engaged in studying the breakdown of visual purple under the influence of light, Lythgoe (1937) made the important discovery that the first step in this process was the formation of an orange intermediate photoproduct which was immediately transformed to indicator yellow, unless the solution before illumination had been cooled in ice. On account of its colour and instability to heat he called this substance "transient orange". The difficult task of measuring the absorption curve for transient orange was successfully tackled by Lythgoe and Quilliam (1938), who found it to possess a maximum around 0·470 μ. This substance may play a part in vision. Thus, as the first result of Lythgoe's work, the old inheritance of concepts with no definite physical meaning such as 'visual yellow' and 'visual white' were replaced by concepts corresponding to substances characterized by their absorption curves and certain other properties such as stability to heat, light, acidity, etc. Kühne's 'visual yellow' embraced both indicator yellow and transient orange. If substances other than these two are formed in the course of bleaching or spontaneous breakdown of visual purple or its yellow photoproduct, as claimed by Wald (1938), they have not yet been demonstrated in a convincing manner. Lythgoe himself was unable to find them.

The discovery by the Danish workers, Fridericia and Holm (1925), confirmed by Tansley (1931) with a more accurate method, that vitamin A deficiency leads to delayed regeneration of visual purple and to nightblindness, inspired several workers to study the vitamin A content of the retina. It was found (Haurowitz, 1933, v. Euler and collaborators, 1933–35, Krause, 1937–38, Wald, 1935–37) that vitamin A and carotene occurred in the pigment layer, but that visual purple was identical with neither substance. However, Wald made the significant discovery that the yellow photoproduct obtained by illumination, or disruption of the visual purple molecule by other means, could easily be extracted by organic solvents and then had the chemical property of a carotenoid. Wald called it 'retinene'. His claim that the final colourless product of bleaching *in vivo* is vitamin A has been opposed by Krause and Sidwell (1938). At any rate, vitamin A is not formed during the bleaching of visual purple in solution. The closely related visual violet, found in certain fishes (Köttgen and Abelsdorff, 1896, Bayliss, Lythgoe and Tansley, 1936) and possessing an absorption spectrum shifted some 0·030 μ towards the red, breaks down in a similar manner, forming a russet-coloured product, another carotenoid, retinene$_2$ (Wald, 1939). It is an interesting fact that retinæ possessing visual violet contain vitamin A$_2$ instead of the ordinary vitamin A$_1$. No doubt, therefore, the A-vitamins are of importance for the formation of the chromophoric group of the visual purple molecule even though it may not be possible at present to describe the nature of this relationship. Lönnberg (1935–37) has isolated large amounts of another carotenoid, xanthophyll, from the retina, and Lythgoe (1940) undoubtedly was right in pointing out that some essential link in our knowledge is missing as long as this finding has not been accounted for.

All old and recent work (Hecht, Krause, Lythgoe, Wald) shows visual purple to be a protein. It has a high molecular weight and is precipitated by water-soluble organic solvents. It shows cataphoretic properties with an iso-electric point (Broda, Goodeve, Lythgoe and Victor, 1939), has the ultra-violet absorption spectrum of proteins (Krause, Goodeve, Lythgoe), and the kinetics of its thermal decomposition, studied by Lythgoe and Quilliam (1939), is consistent with the same view. We may regard visual purple as a 'chromoprotein' in which the chromophoric group is Wald's carotenoid retinene. The molecular weight of that part of the chromoprotein which contains one chromophore is called its 'carrier weight'. Broda, Goodeve and Lythgoe (1940) found the carrier weight to be somewhat below 26·500, a value not far from Svedberg's fundamental protein unit (about 17·600). Putting the molecular weight, determined by Hecht and Pickels (1938), equal to 270·000 and dividing by the carrier weight 26·500, gives the number of chromophores attached to each molecule, which accordingly is about 10. The chromoprotein occupies some 5–10 per cent of the volume of the outer limb of the rod. From different points of view both Lythgoe (Bayliss, Lythgoe and Tansley, 1936) and I arrived at the conclusion that the photosensitive substance is localized on the surface of the rods.

According to Lythgoe (1940), then, light acts on the chromoprotein by loosening the bond between protein and chromophore and so renders the latter more soluble in organic solvents. Thus retinene becomes extractable. Indicator yellow is probably still a conjugated protein, apparently identical with Wald's retinene-protein. Goodeve and Lythgoe think it probable that the essential chemical change caused by the excited visual purple molecule is one of hydrolysis.

Goodeve and Lythgoe in collaboration with Dartnall and Schneider have published several important contributions to the photochemical aspects of the problem. They have determined the quantum efficiency of visual purple (equal to or not far below unity), followed the time course of bleaching, proved that Lythgoe's absorption curve exactly reproduces photosensitivity, determined the molecular extinction coefficient ($2{\cdot}3 \times 10^4$ for wave-length 0·560 μ), and studied the photosensitivity in the ultra-violet. In an aphakic eye (eye without lens) the sensitivity to light was found to reach far out into the ultra-violet (0·300 μ), following there, too, the curve for the photosensitivity of visual purple.

As is well known, visual purple regenerates in the dark, even in solution (Kühne, 1878), though under such conditions to a relatively limited degree (Hecht, Lythgoe). It has been shown by Zewi (1939, 1940) that there are two kinds of regenerative processes in the living retina, one of which is dependent upon the oxygen supply. The other takes place also in a nitrogen atmosphere. A most interesting point is that the rate of regeneration is favoured by previous illumination of the retina (Bauer, 1911, Zewi, 1939) or even *in vitro* by illumination of solutions (Chase, 1937). But if the animals are illuminated with strong light for a *brief* period there may first be a period of absolute standstill of the regenerative processes (Zewi). Now, to quote Lythgoe (1940): "It seems possible that we have two methods for the regeneration of visual purple. Regeneration from its breakdown products almost certainly involves the addition of energy to the system, and this energy can be provided either by the absorption of light or by a chemical process needing oxygen". The vitamins and other carotenoids are probably involved in relatively complex catalysed reactions which so far are unknown. The regeneration from the orange or yellow photoproducts probably consists in a strengthening of the bond between the protein and its chromophore. Lythgoe found regeneration from transient orange to be particularly fast, and made the remarkable statement that the chromoprotein, regenerated from this stage, had an absorption band and other properties which did not quite agree with those of the parent visual purple. He suggested that cone substances may be formed in this manner. Elsewhere (1941, 1943) I have pointed out that the electrophysiological evidence also supports the view that cone substances are closely related to visual purple.

At this stage Lythgoe's work was interrupted by his untimely death, at a moment when he planned collaboration with a biochemist to elucidate the chemical structure of the photosensitive substances in the retina. A particularly fascinating line of research thus awaited Lythgoe just when he had to lay down his tools. How admirably they were used I hope to have indicated by this attempt to interpret a consistent and harmonious development of experiments and ideas, hand in hand.

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PHYSIOLOGY OF COLOUR VISION

By E. N. WILLMER
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IN a previous article in NATURE[1], attention was directed to the possibility that the physiological basis for colour vision might lie in the relative responses of the rods and the cones. A curve was plotted to show the relationship between wave-length and the summation of the rod and cone responses at each wave-length. The characteristics of this curve suggested that it had some affinity with the well-known colour triangle. Further analysis of this phenomenon may not be without interest and also provide answers to certain questions raised by Prof. H. Hartridge in his recent communication[2].

In attempting to decide which was the significant relationship between the rods and the cones—their summation, difference, ratio or what not—the percentage of maximal rod response was plotted against the percentage of maximal cone response, that is, rod sensitivity against cone sensitivity, for each wave-length. The figures were plotted directly from the scotopic and foveal photopic visibility curves given by Abney[3] for the arc-light spectrum, and the result obtained is shown in Fig. 1. This curve has more features in common with the colour triangle than the one to which attention has already been directed.

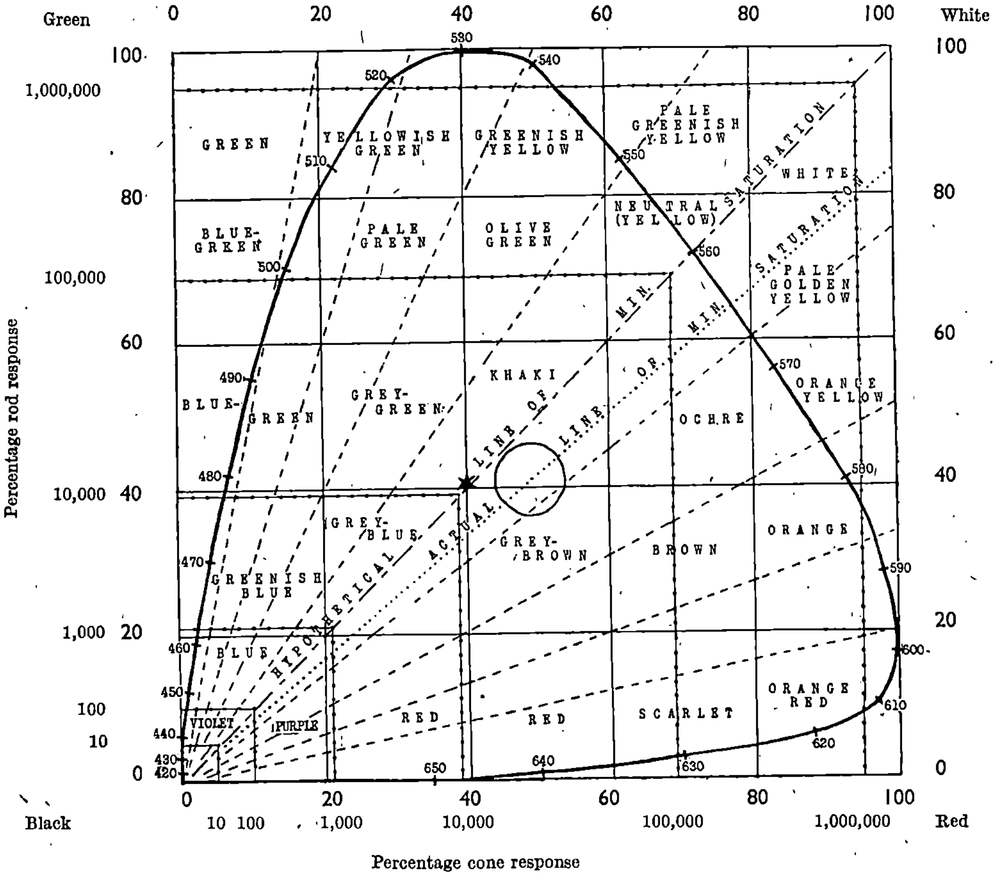

FIG. 1. LOCUS OF THE SPECTRUM IN TERMS OF ROD AND CONE RESPONSE.

Full line, locus of spectral colours; broken lines, direction of movement of locus with change of intensity; lines with dots, levels of light intensity (units in terms of number of times threshold level). Circle indicates region in which lines joining complementary wave-lengths intersect. Star indicates point of intersection of complementaries corrected for intensity.

The C.I.E. colour chart is shown in Fig. 2 for comparison, and it is clear that the curves are strikingly similar except for wave-lengths longer than 600 mμ and shorter than 470 mμ.

The interpretation and significance of this new diagram may now be briefly considered. In the first place the zero point, representing no activity of rods or cones, may be regarded as indicating blackness; conversely the point representing 100 per cent rod and 100 per cent cone activity may be interpreted as white. The line joining the two represents colourless sensation, grey to white. It is the line of minimal saturation and cuts the spectral curve at 560 mμ. The position of minimal saturation in the spectrum is in fact generally found to be between 560 mμ and 570 mμ. The possible significance of this slight difference will appear later. If lines are drawn to connect those pairs of wave-lengths which are complementary, they all, except when wave-lengths greater than 610 mμ are involved, intersect in the region of the circle in the diagram. This would mean that if quantities of the spectral colours were mixed in a 50 : 50 ratio the colour obtained would have its locus in the neighbourhood of the circle. This circle does not quite lie on the line of minimal saturation, but a line joining its centre with the zero point intersects the spectral curve somewhat nearer 570 mμ, that is, somewhat nearer the actual point of minimal saturation in an arc spectrum.

Now it is found that only very few spectral colours are exactly complementary when mixed in equal proportions; nearly always the intensity of one has to be increased. For this and other reasons it is therefore relevant to consider the effects of changes of light intensity in connexion with the diagram. There are no figures available to show the relationship between impulse frequency and light intensity in human optic nerve fibres, but Hartline[4,5] has studied this question in single nerve fibres from the eye of Limulus and also from the eye of the frog. There is a striking similarity between the two, especially when the frog nerve fibre investigated belonged to

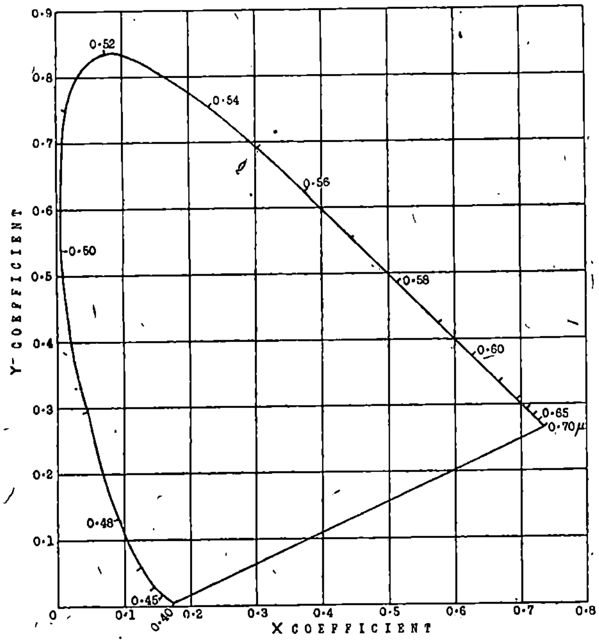

Fig. 2. C.I.E. COLOUR CHART PLOTTED WITH RECTANGULAR CO-ORDINATES, SHOWING LOCUS OF THE COLOURS IN THE SPECTRUM.

the type which discharged continuously throughout the duration of the stimulus. As a first approximation it may therefore be legitimate to use these figures to indicate the extent of the energy changes required to alter the impulse frequencies arising from the rods and the cones. For lack of any knowledge to the contrary both types of sensory cell must be regarded as responding in a similar manner. The results are indicated in the diagram (Fig. 1) in scales along the axes (10, 100, 1,000, etc., times threshold intensity). The lines radiating from the zero point join points having identical rod to cone ratios and thus indicate the change in position of the locus of a colour on the diagram when the light intensity is varied. The energy change involved can be read from the scales on the axes. Now it is found in practice that all wave-lengths of red light longer than 609 mμ, if sufficiently intensified, become complementary to wave-lengths in the region of 490 mμ, and the diagram makes it clear that raising the intensity of colours of long wave-lengths moves their loci all in the direction of 609 mμ. Similarly, all wave-lengths shorter than 430 mμ are complementary to 561 mμ. Now, when lines joining 490 mμ with 609 mμ, and 430 mμ with 561 mμ, are drawn, they intersect on the line of minimal saturation at the point 40, 40. In this connexion, then, all reds beyond 609 mμ may be considered as identical except in intensity, and the same is true for all violets of wave-length shorter than 430 mμ. This would seem to provide an explanation for the telescoping of the spectral extremes in the traditional colour diagram (Fig. 2), and it is probable that the position of the point of minimal saturation in the spectrum is apparently shifted towards the red end of the spectrum because of the energy distribution in the spectrum.

Prof. Hartridge raises the point of why it is not possible to make any other colours than purples, mauves and crimsons by mixing extreme reds and extreme blues in different proportions, since by hypothesis these latter colours respectively stimulate cones only and rods only, and therefore ought to be capable of producing any combination of rod and cone response, that is, any colour. The answer to his difficulty is apparent from the diagram (Fig. 1), since the colour obtained on mixing red and violet pigments will lie along the line joining the loci of the two colours in question and, therefore, in the bottom left-hand corner of the diagram. On mixing lights, greens and browns should theoretically be possible, but never yellows, since the frequencies characteristic of these colours could not be produced from mixtures of violets and reds, for if the intensity of the violets and reds were sufficiently raised they would then be classed as blue-greens or orange-reds. Moreover, in order to raise the impulse frequency from the values characteristic of extreme reds and violets to those characteristic of greens and browns, an increase of light intensity of well over a thousand times would be necessary; and since violets and extreme reds, to be perceived at all, require a high level of illumination, this enormous further increase may be impracticable. It is significant in this connexion that Burch[6] in 1898 noticed that if the intensity of violet light be very greatly increased the sensation of emerald green is produced. This change is predictable from a study of Fig. 1. Similarly and conversely, as the intensity of illumination is diminished, yellow-greens become progressively more blue and oranges more red, changes which are also coincident with those to be expected from consideration of Fig. 1. The eye as a whole is constantly adapting itself to different levels of illumination and has a very wide range even within the limits over which colours can be perceived. The 'white' point made by mixing red and green will in the absence of other brighter light, and because it is colourless, appear white, but if compared with a brighter white it would appear grey.

The second question raised by Prof. Hartridge concerns the effects on the appearance of colours examined after previous adaptation of the eye to violet light which (if the hypothesis be correct) stimulates, and therefore fatigues, rods only, or to red light which conversely should decrease the responsiveness of the cones. The answer to this is

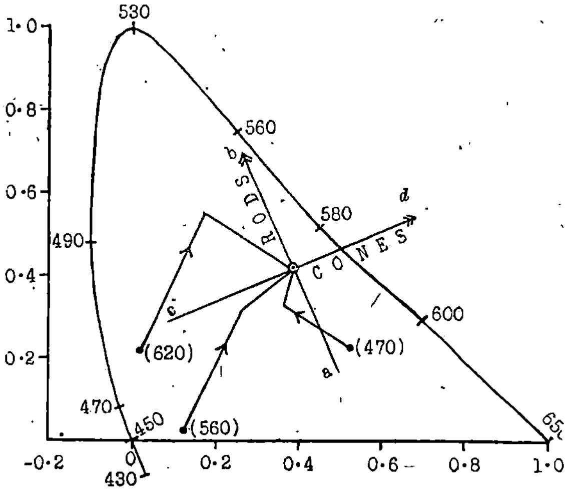

Fig. 3. Colour chart showing the shift of the 'white point' following adaptation to red (620), yellow (560) and blue (470), and the paths followed on its return to the normal position. [Data from Wright (1934).] Probable directions of axes representing rod and cone responses indicated by lines through the 'white point': *ab*, rod axis; *cd*, cone axis.

perhaps best provided by a study of the results obtained by Wright[7] when he investigated this question in 1934. Fig. 3 has been constructed from his data and shows (*a*) the shift in position of the 'white' point in his colour diagram as the result of previously exposing the eye to red, yellow or blue, and (*b*) the paths followed by the locus of the point during its return to the normal position. If this colour diagram be related to Fig. 1 it is probable that the positions of the axes representing rod and cone activity lie roughly parallel to the directions of the lines drawn through the 'white' point. Any movement of the point to the left of the line *ab* indicates depression of cone activity, and any movement of the point to positions below the line *cd*, depression of rod activity. The red (620 mμ) used stimulates rods and cones in the proportion of 7 : 90 and the displacement of the 'white' point is in the proportion of 4 units along the rod axis and 42 units along the cone axis. The corresponding figures for the blue (470) and the yellow (560) are shown in the following table :

	Stimulation		Displacement	
	Rods	Cones	Rods	Cones
Red	7	90	4	42
Blue	30	5	22	5
Yellow	72	72	25	40

The figures speak for themselves, so far as the initial displacement is concerned ; the significance of the recovery paths is not so clear, but may be related to the different rates of recovery of the rods and cones and to general re-adaptation to the experimental conditions required for making the necessary matches.

The figures used throughout this article have, as already stated, been derived from the scotopic and foveal photopic visibility curves for the arc-light spectrum. The diagram will be considerably modified for spectra with different energy distribution, and the exact shape and position of the visibility curves s consequently of importance in any more detailed analysis. That the foveal visibility curve is so similar to the ordinary photopic curve and apparently can be regarded as the cone curve is of nterest in that it suggests that at all levels of llumination at which cones are functional it is chiefly to their activity that we owe the sensation of brightness.

Finally, it is of interest to note that the line of minimal saturation divides the spectral curve into two portions, and the distance from this diagonal epresents the positive or negative difference between the rod and cone responses for each wave-length. Distances along the diagonal represent the summation of the rod and cone responses. Since the differences vary with the wave-length, it is not surprising that the summation of rod and cone responses when plotted against wave-length should have some of the properties of the colour triangle, as was noted in the previous article[1].

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OBITUARIES

Sir Arthur Newsholme, K.C.B.

SIR ARTHUR NEWSHOLME was born at Haworth, the village of the Brontës, on February 10, 1857. He received his medical education at St. Thomas's Hospital and took the degree of M.D.(Lond.) after a brilliant academic career. After holding resident appointments at St. Thomas's and other hospitals, he started in general practice at Clapham. But his interest was early directed towards public health, for in 1884 he was appointed part-time medical officer of health for Clapham, and took the public health diploma at the University of London. His early reports show the application of scientific principles to the study of disease outbreaks and reveal that he was already making a special study of problems of local and national vital statistics, density of population as a factor in excessive death-rates, and the need for local intensive comparison of death-rates. In 1884 he published a book on "Hygiene", and in 1887 a manual on "School Hygiene".

Newsholme rapidly became a leading authority on public health ; this was recognized by his appointment as whole-time medical officer of health of Brighton in 1888. Here he worked indefatigably and enhanced his reputation as an administrator and a scientific investigator. The writing of "The Elements of Vital Statistics", a standard text-book, led to the offer of the post of medical statistician in the General Register Office, which he declined in favour of Dr. T. H. C. Stevenson. He added to knowledge in his investigations of the epidemiology of tuberculosis, scarlet fever and diphtheria, and in 1895 gave the Milroy Lectures at the Royal College of Physicians on "The Natural History and Affinities of Rheumatic Fever". In these four lectures Newsholme showed that rheumatic fever is an infective disease, that 'explosive' and 'protracted' epidemics occur, that there is evidence of cyclical prevalence, that epidemics can occur in years of minimum rainfall and that the disease varies greatly in extent in different countries. The statistical approach to this and other problems of disease revealed facts of fundamental importance. A statistical study of "The Alleged Increase of Cancer" (with G. King), contributed to the *Proceedings of the Royal Society* in 1895, also broke fresh ground.

In 1908, Mr. John Burns appointed Newsholme as medical officer of the Local Government Board. The State was beginning to see that national health is not solely a matter of environmental hygiene. A beginning had been made with the setting-up of the School Medical Service under the Board of Education, and National Health Insurance was already foreshadowed. In his ten years tenure of office, Newsholme laid the medical foundation of the national health services—tuberculosis, maternity and child welfare, and venereal diseases—as well as making notable contributions to the public health side of the national war effort during 1914–18.

Newsholme was a kind and sympathetic chief ; he worked hard himself and expected his staff to work with equal energy and enthusiasm. He was made a C.B. in 1912 and was advanced to K.C.B. in 1917. With the advent of the Ministry of Health, he retired and accepted an invitation to lecture on public health at Johns Hopkins University in 1920 and 1921. He had a great regard for the peoples of the United States, and closely forged the links of co-operation in health and social reform between the two nations. This influence is exerting its force to-day.

In the years of retirement, Newsholme's facile pen was seldom idle; and he visited many countries, including the U.S.S.R., to study their health conditions and to discuss their problems. His last two books, "Fifty Years in Public Health" and "The Last Thirty Years in Public Health", are not only autobiographical, but also possess scientific and historical value. Tall, handsome and bearded, with many social gifts, Sir Arthur was a popular figure in Great Britain and the United States. He married in 1881 Sara Mansford, and her death in 1933 was a great blow to him. Newsholme's work as administrator and epidemiologist takes high place in the story of British public health.

ARTHUR S. MACNALTY.

WE regret to announce the following deaths:

Dr. W. S. Bayley, who retired in 1931 from the professorship of geology at the University of Illinois, where he was head of the department, on February 14, aged eighty-one.

Mr. Lionel R. Crawshay, at one time a member of the scientific staff of the Marine Biological Association and for many years research officer, Sponge Fishery Investigations, West Indies and British Honduras, on April 24, aged seventy-four.

Prof. Kurt Huber, professor of experimental psychology in the University of Munich, recently executed for "traitorous conspiracy".

Prof. Martin H. Knutsen, professor of bacteriology at the Pennsylvania State College since 1928, on February 6, aged fifty-five.

NEWS and VIEWS

King's Birthday Honours

THE following names of men of science and others associated with scientific development appear in the King's Birthday Honours list:

Baronet: Sir John Fraser, regius professor of clinical surgery, University of Edinburgh.

K.C.B.: Dr. N. K. Johnson, director of the Meteorological Office.

K.B.E.: Sir T. Franklin Sibly, vice-chancellor of the University of Reading, and chairman of the Committee of Vice-Chancellors and Principals.

Knights: Capt. J. P. Black, managing director of the Standard Motor Co., Ltd., and chairman of the Joint Aero-engine Committee; D. A. E. Cabot, chief veterinary officer, Ministry of Agriculture; Dr. H. L. Eason, president of the General Medical Council; Dr. C. S. Fox, director of the Geological Survey, India; Dr. H. Spencer Jones, Astronomer Royal; J. M. Kennedy, deputy chairman of the Electricity Commission; P. M. Kharegat, vice-chairman, Imperial Council of Agricultural Research, India; E. Macfadyen, chairman of the governing body, Imperial College of Tropical Agriculture; Dr. A. D. McNair, vice-chancellor of the University of Liverpool; Prof. J. L. Myres, formerly Wykeham professor of ancient history, University of Oxford, for services to learning; Prof. G. P. Thomson, professor of physics, Imperial College of Science and Technology.

C.H.: E. W. Hives, for services in the design of aero-engines.

C.B.: J. M. Caie, deputy secretary, Department of Agriculture for Scotland; W. S. Farren, director, Royal Aircraft Establishment, Ministry of Aircraft Production.

C.I.E.: H. Trotter, utilization officer, Forest Research Institute, Dehra Dun.

C.B.E.: R. Chadwick, chief designer and director, A. V. Roe and Co., Ltd.; Dr. H. L. Guy, chairman of the Gun Design Committee, Scientific Advisory Council; Prof. J. Jewkes, deputy director-general of statistics and programmes, Ministry of Aircraft Production; Prof. J. N. Mukherjee, professor of chemistry, University of Calcutta; R. K. Pierson, chief designer, Vickers-Armstrong, Ltd. (Aircraft); Major R. W. Sharpe, chairman, Agricultural Executive Committee, Berwickshire; Lieut.-Col. W. W. Zambra, secretary, Imperial Communications Advisory Committee.

Prof. V. M. Goldschmidt, For.Mem.R.S.

PROF. V. M. GOLDSCHMIDT, whose election to foreign membership of the Royal Society has just been announced, has made outstanding contributions in each of the fields of petrology, crystal chemistry and geochemistry. His early studies in rock metamorphism marked a major advance in the correlation of the chemical and mineralogical composition of thermally reconstituted rocks and contained the first successful essay towards a systematic classification of rock-mineral assemblages in the light of the phase rule. The leader of great schools of geochemistry both at Göttingen and Oslo, Goldschmidt has for many years devoted his attention to the discovery of the principles governing the terrestrial distribution of the elements: in this programme his classical researches on the crystal structure of ionic compounds were early achievements and may be regarded as laying the foundation of the science of crystal chemistry. His exhaustive series of investigations on the chemical composition of rocks and minerals has revolutionized our knowledge of the distribution of the minor constituents of the earth's crust, while his similar studies on meteorites have brought a special contribution to the problem of the chemistry of the earth's deep interior. It is in these comprehensive researches, both geochemical and crystallochemical, that Goldschmidt has contributed in such large measure to the present-day picture o the geochemical evolution of matter within the lithosphere.

Prof. B. A. Houssay, For.Mem.R.S.

PROF. BERNARDO ALBERTO HOUSSAY, of Bueno Aires, elected a foreign member of the Royal Society on May 20, is one of the outstanding men of science of Latin America. He has held the chair of physiology in the University of Buenos Aires since 1919, and ha made his laboratory a leading centre for endocrine research. His most remarkable discoveries concern the effect of the anterior pituitary body on carbo hydrate metabolism; he showed that although the removal of the pancreas alone will cause diabetes yet if the anterior lobe of the pituitary is removed at the same time the animal has no glycosuria and stays in reasonable health. Further analysis made it clear that the anterior lobe of the pituitary secrete a hormone with an opposite effect on sugar metabolism to that of insulin, and that it is the absence of this hormone in the 'Houssay animal' which accounts for the lack of glycosuria when the pancreas is removed. Many other chapters in the complex story of endocrine interactions have been worked out in Prof. Houssay's laboratory and he has recently dealt with the problem of renal hypertension and the nature of the toxic substance which may be liberated by a diseased kidney. He is an honorary member of the Physiological Society and has published various papers in the *Journal of Physiology*.

Prof. T. J. Jehu: Retirement from Chair of Geology at Edinburgh

In his student days T. J. Jehu, who is retiring from the regius chair of geology and mineralogy in the University of Edinburgh, had an unusually varied and distinguished career: at Edinburgh he graduated M.B., C.M. (1893), and B.Sc., with the class medal in geology (1894); at Cambridge he took a first class in both parts of the Natural Science Tripos (1897, 1898) and second class in the Moral Science Tripos (1899). Later, Jehu became lecturer in St. Andrews (1903–14), during which time he served on the Royal Commission on Coast Erosion (1906). In 1914 he returned to Edinburgh as professor of geology; and it was during his tenure of office that the Grant Institute of Geology was founded and endowed.

Jehu's scientific papers have always been of unusual interest, and have mostly appeared in the *Transactions of the Royal Society of Edinburgh.* Until he left St. Andrews, the lakes and glaciation of Wales specially attracted his attention. He sounded the lakes of Snowdonia, and he investigated the interaction of the local and Irish Sea ice in both Pembrokeshire and Carnarvonshire. In 1917 he published a memoir with Robert Campbell on "The Highland Border Rocks of the Aberfoyle District", making an outstanding contribution to our knowledge of the Cambro-Ordovician sequence of the south-east margin of the Scottish Highlands, especially in regard to its palæontology. In 1922 he produced "The Archæan and Torridonian Formations and Later Intrusive Igneous Rocks of Iona". This publication is important in itself, but is now chiefly remembered as a prelude to the "Geology of the Outer Hebrides", which Jehu and R. M. Craig brought out in five parts between 1923 and 1934. It is not too much to say that this serial chronicled the greatest bit of field geology tackled by any British university during the present century. Its outstanding characteristic is its treatment of a belt of flinty crush rock found along the eastern shores of the Western Isles. Here, of course, Jehu and Craig share credit with J. W. Dougal; but plenty remains to ensure for Prof. Jehu in his retirement the warm gratitude of fellow workers in Scottish geology.

Prof. Arthur Holmes, F.R.S.; Appointed to Chair of Geology at Edinburgh

Prof. Arthur Holmes, of the University of Durham, who succeeds Prof. Jehu as regius professor of geology in the University of Edinburgh, has an international reputation in the fields of petrology and geophysics. His name became closely linked with the classic pioneer work on radioactive minerals while he was still a junior member of staff at the Imperial College, South Kensington. He applied this new kind of quantitative data to a re-assessment of the age of the earth, and deduced the approximate period of time spanned by each of the geological ages in sequence—from Pre-Cambrian time to the present day. His contribution to both descriptive and interpretative petrology is voluminous and impressive. His later work incorporates many thought-compelling reviews of conventional hypotheses concerning the thermal history of the earth, the physical state of the earth's interior, the nature and variability of magma, and the origin of igneous rocks. His contributions to geology have profoundly influenced the scope and trend of contemporary work in the field of petrogenesis, and in close co-operation with Dr. Doris L. Reynolds he has in recent years amassed data demonstrating the effectiveness of alkali-metasomatism, transfusion by emanations from deep-seated sources, and granitization—as processes transcending in importance those accommodated within the framework of conventional petrogenetic theory.

U.S. National Academy of Sciences

First Charles L. Mayer Award

Prof. Charles B. Huggins, professor of surgery in the University of Chicago, has been awarded a two thousand dollar prize given by Dr. Charles L. Mayer and administered by the National Science Fund of the U.S. National Academy of Sciences. The award was offered for the "most outstanding contribution made during 1942 to present-day knowledge of factors affecting the growth of animal cells with particular reference to human cancer, and as a new type of prize for the advancement of fundamental scientific research administered under a new type of philanthropic foundation". The award was made to Prof. Huggins for his studies of the human prostate, with special relation to the cancers taking origin from this gland. He has shown that certain hormones which regulate the normal activities of prostatic cells have a marked influence as well on many of the cancers that are derived from them. By the utilization of this knowledge he has been enabled to control the growth of the cancers and of such secondary tumours as may already have formed in distant organs. These discoveries have large theoretical as well as practical implications.

A second Charles L. Mayer award of two thousand dollars for an outstanding study made in the same field in 1943 will be given, and entries and recommendations for consideration for this award should reach the office of the National Science Fund, 515 Madison Avenue, New York City, by January 15, 1944. The Advisory Committee is interested primarily in fundamental studies on the factors influencing growth of animal cells rather than applications to any particular aspect of normal or abnormal growth.

Visual Aids to Education

A small exhibition of visual aids to education was held in the Conference Room of the Board of Education on May 25 and 26. This was organized for the Conference of Ministers of Education of Allied Governments meeting under the chairmanship of Mr. R. A. Butler, president of the Board of Education. The Board has already published a pamphlet dealing with mechanical visual aids. Here the problem was reviewed from a wider angle. The blackboard is the fundamental instrument of visual teaching. The problem of improving illustrated text-books is acute

—the standard is very low. Meanwhile, until films are made to the requirements of teachers, really educational films are hard to get. The position of the sound-film is particularly difficult—facetious commentaries and lack of precise facts are obvious. Many teachers are turning from the film to other aids; of these the strip-film is the most important. In addition to the demonstration of class-room and background exhibitions, the need for making visual material available to the schools was stressed. Much useful material is available in museums, and teachers must be helped and guided in its use. The question of recording all exhibitions in booklet form is important. The Warburg Institute has done valuable work in this direction by means of photographs. Now the Army Bureau of Current Affairs, the Navy and many public bodies are arranging exhibitions, which contain material, facts and ideas of great educational use. Some central organization is needed to preserve this valuable work for educational purposes.

Place of Psychology in the Sciences

ADDRESSING a colloquium of the University of Manchester Branch of the Association of Scientific Workers on May 5, Prof. T. H. Pear explained why in psychology the traditional methods of science are sometimes inadequate. Science has sometimes been defined as measurement and sometimes as organized knowledge of facts, but not all facts can be measured. Moreover, if by facts be meant only events which are in principle open to observation by everyone who wishes to observe them, the psychologist has to study many phenomena, for example, mental images and colour experiences, which are not facts in this sense. Some would claim that they are therefore not amenable to the methods of science, but nevertheless they exist and are important; synæsthesia, for example. Physics has succeeded in maintaining a rigorous scientific method by ignoring certain difficult aspects of experience.

Prof. Pear said that there are few 'inner' inhibitions against analysing or manipulating inanimate matter; more against studying the workings of the human body, and still more against intimate investigation of the mind. He urged the study of individuals side by side with the search for general laws. If this is not to be called science, scientific men should remember that in the case of human beings it may often be the more important study. He concluded by suggesting that the motives of the economist, the politician, of even the man of science, are subjects which interest the social psychologist.

Light and Vision

AT a meeting of the Illuminating Engineering Society following the annual general meeting on May 11, Sir John Parsons gave an address on "Light and Vision". In his opening remarks Sir John recalled his presence at the inaugural dinner of the Society in 1909, and the recognition of the founder of the Society, Mr. Leon Gaster, that its aims were not limited to physical problems, but involved physiological, psychological and æsthetic factors. At that time there was little guidance on lighting matters from the medical side, but engineers had themselves little data, and instruments for measuring illumination were primitive and cumbersome. The first paper read to the Society on glare in 1910 was given by himself, and the Society has since been preoccupied with this and similar problems involving vision. Sir John then discussed the relation between illumination and visual acuity, directing attention to the valuable work of Dr. Lythgoe and others and the development of the Illuminating Engineering Society's Code. Research has established the great importance of background and adequate contrast. The work of Dr. Stiles and others on glare (for which we have no actual physiological test), the effects of specular reflection from polished material and the inconvenience and occasional danger of harsh shadows—most difficult, however, to define with precision—were dealt with. Turning to the colour of light Sir John expressed the view that there is no evidence that artificial sources furnishing so-called 'white light' cause any harmful effects. The injurious effects of ultra-violet light in everyday life have been grossly exaggerated and the craze for 'daylight' lamps has been unwarranted.

Much of the later part of the address was devoted to vision at low illuminations, the peculiar appearance of colours in weak light and the conditions determining the perception of objects at the very low illuminations which are now experienced in the streets in war-time. Reference was made to the work of the Departmental Committee on Lighting in Factories and Workshops, and to the fact that legislation on factory lighting, recommended before the War of 1914–18, has only become a fact during the present War. Sir John referred to the value of the Illuminating Engineering Society Code and the recent researches on this subject by Mr. H. C. Weston, in which an effort has been made to give a scientific background without greatly disturbing the present set of values, which have become standard. The fact that requirements for adequate lighting in factories had now been incorporated in the Factory Act should serve as a precedent for the future, when lighting conditions in schools, offices, etc., might likewise be defined and standardized. The recognition of the I.E.S. Code during the War has been largely due to the fact that it was ready when needed. Now, therefore, is the time to complete codes and specifications relating to other fields of lighting.

Protection of Structures Against Lightning

J. F. SHIPLEY, in a paper read in London before the Institution of Electrical Engineers on May 6, points out that the British Standards Institution has recently issued recommendations on this subject which constitute the first authoritative general guidance made available to the public in Great Britain since the Report of the Lightning Rod Conference in 1881 and its amendment by the Lightning Research Committee in 1905. These new recommendations have been adopted by the Ministry of Works and Planning as its first code of practice, the latter containing additional appendixes in which comment is made on some of the new features dealt with, and which the present paper amplifies to some extent. The paper is confined to problems connected with the protection of modern steel-framed and ferro-concrete structures. The need for protection is discussed and a rough attempt is made to assess the lightning risk attached to any structure in any part of the world. The zone of protection receives attention and the presence of metallic systems in the buildings is mentioned; while the needs of structures which are very vulnerable to lightning, and of others which present difficult problems, are discussed. The components of a lightning protective system, their materials, dimensions and cost are referred to, and finally inspection, testing and records are dealt with.

More information is needed on the behaviour of large currents of lightning magnitude when earth electrodes of rod and strip in various combinations are used, with various simple soils such as chalk, clay, loam and sand. The influence of bends upon side-flashing when similar currents are discharged through a down conductor is not known exactly, and much more reliable data are required. Another sphere of uncertainty is whether to isolate a lightning protective system or to bond it to the metallic sheaths of other services. The ability of electric conduit to carry a share of the lightning discharge current (as might be the case if bonding were carried out in a very tall building such as a lighthouse) is doubtful, and much more data are needed. The statistical data available from the Meteorological Office on the prevalence of lightning over the major portion of the world will be very valuable, and if the larger British and Overseas fire insurance companies could be induced to provide separate statistics for lightning claims, later recommendations for protection against lightning would be increasingly trustworthy.

Changes in Mortality-Rates in the United States

HAROLD F. DORN, of the United States Public Health Services, states (*Public Health Rep.*, Dec. 4, 1942) that between 1930 and 1940 the expectation of life at birth of the total population of the United States increased from 59 to 63·3 years, an increase of 4·3 years, or 7 per cent. At the beginning of the century, the expectation of life at birth was 49·2 years as compared with 63·3 years in 1939, an increase of 14·1 years or 29 per cent. The relative increase in life expectancy was nearly twice as great for non-whites as for whites. The largest relative decreases occurred in the death-rates of children and young adults, but significant decreases took place throughout life even among the older persons. With the exception of deaths from heart disease, cancer and diabetes, the mortality from each of the important causes of death was lower in 1939 than in 1930. For the first time in the history of the registration area, the maternal mortality-rate declined uninterruptedly throughout the entire decade, the relative decrease being 48 per cent among white mothers and 34 per cent among negro mothers.

Chinese Students for Britain

TEN Chinese students, the first to visit Britain under a new scheme operated by the British Council, are now on their way to Great Britain. They have been given scholarships by the Council, and will study some branch of engineering and will work at the university or college most suited to their special qualifications. Their training is expected to be of special value both because it will equip them for reconstruction work in China, and because their familiarity with British engineering practice and equipment will furnish a link between Great Britain and China.

The names of these students, with their qualifications, are as follow: Shen Yuan (B.Sc. in aeronautical engineering, National Tsing Hwa University, 1940; assistant, National Southwest Associated University, 1940–42; to study aeronautical engineering). Tsao Pung Hyi (B.Sc. in chemistry, National Tsing Hwa University; research student, Research Department of Agriculture, National Tsing Hwa University, 1938–39; assistant, Chemistry Department, National Tsing Hwa University, 1939–42; at Li-Tien Chemical Works, 1942–43; to study chemical engineering). Yuan Sui Shan (B.Sc. in civil engineering, National Tsing Hwa University, 1938; assistant, Civil Engineering Department, National Southwest Associated University, 1938–41; associate engineer, Bureau of Transportation Administration, 1941–42; to study shipbuilding). Meng Ching Yuen (B.Sc. in electrical engineering, National Chiao Tun University, 1938; apprentice, Electrical Administration, Kwangsi, 1939; technician, Ministry of Communications, 1939–40; assistant engineer, Central Electrical Works, 1940–42; to study electrical engineering). Lyn Wei Tze (B.Sc. in mechanical engineering, National Tsing Hwa University, 1940; technician, Fifth Army, 1938–39; assistant, National Southwest Associated University, 1940–42; to study mechanical engineering). Chen Ju Chuan (B.Sc. in chemical engineering, National Chekiang University, 1937; associate engineer, Yunnan Tin Works, National Resources Commission, 1937–39; assistant, Chemistry Department, National Southwest Associated University, 1940–42; to study textile engineering). Lao Ti Li (B.Sc. in chemistry, National Tsing Hwa University, 1940; chemistry assistant, National Central University, 1940–41; chemistry assistant, National Tsing Hwa University, 1942; to study pharmacy). Chang Tse Shuan (bachelor of law, National Tsing Hwa University, 1940; assistant, Economics Department, National Tsing Hwa University, 1940–42; to study planning economics). Fang Pin (B.Sc. in metallurgy, National Yunnan University, 1941; apprentice, Kun-hwa Iron and Coal Works, 1939–40; associate engineer, Yunnan Metal Works, Ministry of Economic Affairs, 1941–42; engineer, Metal Works of Western Yunnan, Ministry of Economic Affairs, 1941–42; to study metallurgy). Prof. Tseou Heou Feo (doctor of science, University of Paris; formerly professor of chemical engineering, National Chekiang University; dean of College of Science, National Szechuan University).

Announcements

THE Minister of Agriculture has appointed Prof. E. J. Salisbury, F.R.S., Quain professor of botany in University College, London, to be director of the Royal Botanic Gardens, Kew, as from September 1.

THE ABBÉ HENRI BREUIL has been elected an honorary Fellow of the Royal Society of South Africa.

DR. ISAIAH BOWMAN, president of the Johns Hopkins University, previously director of the American Geographical Society, has been elected president of the American Association for the Advancement of Science, to succeed Dr. Arthur H. Compton, of the University of Chicago. Due to the postponement of the New York meeting Dr. Bowman was elected by postal ballot.

THE following have been elected officers of the Illuminating Engineering Society for the forthcoming session: *President:* Dr. H. Buckley; *Vice-Presidents:* Mr. E. Stroud, Dr. W. M. Hampton and Mr. H. C. Weston; *Hon. Treasurer:* Mr. N. V. Everton; *Hon. Secretary:* Mr. J. S. Dow; *Members of Council:* H. E. Chasteney, E. E. J. Drake, F. S. Ette, J. G. Holmes, W. C. Huston, H. Lingard, J. F. Stanley, J. W. Whitaker and T. Wilkie.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Sex Difference in Blood-Group Frequencies

Two or three years ago, when comparatively large bodies of blood-group data were being examined by one of us (R.A.F.), it was noted that at an unexpectedly large number of centres in Yorkshire there were proportionately more women *O*'s than men and more men *A*'s than women.

Subsequent examination of records obtained from various parts of Great Britain has yielded clear, positive evidence in one area, which also proves to be homogeneous in the relative proportions of *O* and *A*. The records are those of the Army Blood Transfusion Service and relate to the six south-western counties of England. In view of this apparently unequivocal finding it seems desirable to place the facts on record, while pointing out that the data for the other areas are an interim summary provided for comparison.

The count in the south-western area included 120,874 donors. The numbers of women and men *O*'s and *A*'s are as follows:

	Women	Men
O	33,042	20,702
A	32,225	20,925

In terms of percentages (ignoring groups *B* and *AB*), 49·37 per cent of women fall into group *A*, compared with 50·27 per cent of men. Testing for homogeneity by means of a 2 × 2 comparison, χ^2 equals 8·086 (using Yates's correction for continuity). Thus the chance of obtaining two such diverse samples from homogeneous material is no more than one in 450.

The difference, taking the material as a whole, is highly significant, but it is important to examine the homogeneity of its constituent parts. Population movements or concomitant variations in sex-ratio and the relative proportions of *O* and *A* might create false associations. The records from the six counties were tabulated separately for nine areas centred on the towns named in the table below. (It should be explained that the high proportion of men in the Cheltenham area is due to the inclusion of many employees of the Great Western Railway Company at Swindon.)

Area	Women		Men		Sex difference in per cent *A*/(*A*+*O*)
	O	*A*	*O*	*A*	
Cheltenham	4,049	3,775	4,760	4,876	+ 2·35
Bristol	10,283	10,237	7,656	7,747	+ 0·41
Salisbury	2,045	2,119	786	802	— 0·49
Dorchester	1,257	1,228	594	527	— 2·41
Bridgwater	4,392	4,197	2,492	2,487	+ 1·09
Exeter	6,279	6,132	2,146	2,193	+ 1·13
Plymouth	316	276	74	96	+ 9·85
Barnstaple	2,577	2,510	1,036	1,074	+ 1·56
Truro	1,844	1,751	1,158	1,123	+ 0·52
Total	33,042	32,225	20,702	20,925	+ 0·90

The area is not significantly heterogeneous in the proportions of *O* and *A*, either in the case of the total figures or in either sex separately. Making a 2 × 9 comparison, χ^2 equals 13·284 in the case of the women, 9·488 in the case of the men, and 13·566 in the case of the totals. The corresponding values of *P* are 0·10, 0·30 and 0·09.

In view of the homogeneity in the proportions of *O* and *A*, it is sufficient to examine the homogeneity of the sex difference throughout the area by calculating χ^2 separately from each of the nine 2 × 2 tables, summing and deducting the χ^2 for the total. The remainder, corresponding to 8 degrees of freedom, represents heterogeneity.

The result is as follows:

	Degrees of freedom	χ^2	*P*
Sum for nine areas	9	21·096	0·012
Total for whole area ..	1	8·086	0·0045
Difference attributable to heterogeneity	8	13·010	0·111

There is no significant heterogeneity, therefore, within the area in respect of the sex difference.

It is unlikely that population movements could produce this difference in such a large and homogeneous area. There is, however, a stronger argument. Only movement into (not out of) an area of persons of different blood-group frequencies, a movement unequal as between the sexes, could produce such an effect. Men migrate more than women and as this area is already as high in *A* as any other part of the British Isles, it follows that a movement of population into it would tend to lower the proportion of men *A*'s, the reverse of the effect observed.

The Yorkshire data, divided into eleven areas, are shown in the accompanying table.

Area	Women		Men		Sex difference in per cent *A*/(*A*+*O*)	Weight
	O	*A*	*O*	*A*		
Bradford	7,218	6,165	4,165	3,596	+ 0·26	1·97
Halifax	2,178	1,995	1,342	1,265	+ 0·72	0·64
Huddersfield	1,860	1,542	1,385	1,264	+ 2·39	0·60
Leeds	7,438	6,294	3,921	3,511	+ 1·41	1·93
Sheffield	7,811	7,238	7,119	6,793	+ 0·73	2·89
Wakefield	1,692	1,522	1,431	1,269	— 0·36	0·59
Hull	4,272	3,648	2,595	2,135	— 0·92	1·18
East Riding	1,284	1,040	645	590	+ 3·02	0·32
Vale of York	2,654	2,318	1,599	1,408	+ 0·20	0·75
West Riding excluding Skipton and Settle	13,375	11,081	10,031	8,407	+ 0·19	4·20
Skipton and Settle district of West Riding	1,353	1,075	755	616	+ 0·66	0·35
Total	51,135	43,918	34,988	30,854	+ 0·51	15·42

In every district save two, Wakefield and Hull, the proportion of *A*'s is higher among the men than among the women. As there are in this region considerable geographical variations in the relative proportions of *O* and *A*, and also large variations in sex ratio, a comparison of the totals alone might well be misleading. Consequently, a weight has been calculated for each area, using:

$$w = 0{\cdot}0004 \div \left(\frac{1}{N_1} + \frac{1}{N_2}\right),$$

for N_1 women and N_2 men. The weighted mean difference calculated in this way is 0·51 per cent compared with 0·90 for the West Country data. The eleven districts are perfectly homogeneous for sex difference, χ^2 being less than 10 for 10 degrees of freedom, and the average difference is significant beyond 1 in 20, or 1 in 40 if direction is taken into account. Had the total figures been thrown together, the inflated differ ence of 0·66 per cent would have considerably magnified the apparent significance of the sex difference.

A series of 7,322 *O*'s and *A*'s from Coventry yields women 47·609 per cent, men 51·008 per cent, a difference consistent with that found in the larger samples, but scarcely consistent with zero difference. Wolverhampton, with 6,379 donors, gives a similar result, but certain discrepancies in the case of these figures make it safer not to rely upon them at present.

A large and undoubtedly reliable sample obtained by Dr. Janet Vaughan at Slough, and counted from time to time at the Galton Laboratory, shows no sex difference in the ratio $A : (A + O)$. Among 70,000 donors, we find women 49·604 per cent and men 49·355 per cent. The women are thus slightly higher in *A*, the difference being non-significant. This result is in definite conflict with those of south-west England and Yorkshire. It is possible, however, that the absence of a sex-difference is to be ascribed to population movements, for it cannot be doubted that the London area, above all others, constantly receives from Scotland, Ireland, Wales and the north an influx of immigrants with a lower percentage of *A*, and a preponderance of men.

As the evidence stands, then, the difference is highly significant in south-western England and moderately significant in Yorkshire, while some supporting evidence is provided in the Midlands by Coventry, and possibly by Wolverhampton. The large sample from Slough is in definite disagreement, though a reasonable explanation can be offered for the discrepancy. Whatever the explanation may be found to be, we feel that the empirical evidence has now accumulated to a point at which its indications must be recognized.

We wish to thank Brigadier L. E. H. Whitby and the staff of the Army Blood Transfusion Service, especially Major B. Lacey, Captain T. Fortescue Fox and Mr. R. J. McCrudden for the excellent facilities so readily placed at our disposal. We are also greatly indebted to Dr. M. S. Stanbury for access to the Yorkshire forms.

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Hexose Dehydrogenase

EXPERIMENTS on a hexose dehydrogenase have been in progress in this laboratory since November 1940, and many useful data have been collected. A recent communication[1] makes it desirable to publish the results so far obtained.

The most potent preparation of the enzyme has been obtained from *Phaseolus mungo* and *P. radiatus* eeds. The enzyme has also been found in the small ntestines of animals, including the guinea pig. The erobic and anaerobic dehydrogenation of the hexoses y the enzyme produces ascorbic acid, as found by itration with 2 : 6 dichlorphenol indophenyl under uitable conditions. The enzyme is equally active owards glucose, galactose and mannose; but fructose nd sorbose are not as good substrates as the other hree sugars. Fructose and sorbose are, however, onverted to ascorbic acid, to a smaller extent, by he enzyme. The disaccharides and the pentoses canot act as substrates. Thus it would appear that the nzyme is an aldohexose dehydrogenase. The enzyme preparation from the germinating legumes produces both ascorbic acid and dehydroascorbic acid, owing to the simultaneous presence of the oxidizing enzyme (ascorbic acid oxidase), while the enzyme from the small intestines of animals produces ascorbic acid only.

The optimum *p*H for the enzyme is 6·5. Potassium cyanide in concentrations of 20 mgm. per cent or more, but not hydrogen sulphide, is an inhibitor of the enzyme. Manganese has been found to be the co-enzyme of the dehydrogenase. The addition of the manganese ions in suitable concentrations not only activates the enzyme but also, after electrodialysis of the enzyme extract, synthesis of ascorbic acid takes place only on the addition of manganese. Nickel is very slightly active in this respect, but magnesium, copper and iron are inactive.

The enzyme preparation from the germinating legumes was made by grinding the germinated seeds with cold water, centrifuging and filtering the clear extract through ashless filter paper. From the small intestines, the enzyme extract was made by extracting the acetone-dry intestines with water at 0° C. for 2–3 hours, centrifuging and filtering. 1 c.c. of the enzyme extract was incubated with 1 c.c. sugar solution (25 mgm.) and 3 c.c. phosphate buffer of *p*H 6·5, 1 c.c. of distilled water replacing the sugar solution in the control. Time of incubation was 3–4 hours. A few results are given in the accompanying table.

Source of enzyme	% Mn in incub. mix.	Ascorbic acid synthesis (mgm./gm. original sub.)		
		Undialysed enzyme extract		Electro-dialysed extract
		in air	in nitrogen	
P. mungo	nil	0·08	—	nil
,,	0·001	0·20	—	—
,,	0·005	—	—	0·12
P. radiatus	nil	—	—	trace
,,	0·001	—	0·17	—
,,	0·001	—	—	0·11
Rat intestines	0·005	—	—	0·02

It is evident that on electrodialysis the activity of the enzyme is inhibited slightly, or that some unidentified activating substance is lost. Manganese acts in association with some protein carrier. The protein is probably an albumin. Some evidence for this has been obtained by examining the activity of albumin – manganese mixtures.

The enzyme is partly precipitated by acetone but attempts to prepare a highly active enzyme in this way have not been successful; the preparation of a stable and highly active dry enzyme is under investigation.

Nov. 15, 1942 [delayed in transmission].

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[1] Baser and Karkum, Proc. 29th Ind. Sci. Congress, Pt. 4, 5 (1942).

IT has been shown [above] that the enzyme preparation from acetone-dry small intestines of animals can synthesize a comparatively small amount of ascorbic acid. The probable explanation is that the enzyme is denatured by acetone treatment. This is suggested by the fact that the enzyme preparation obtained by extracting the fresh jejunum of the goat and guinea pig shows synthesis of a greater amount of ascorbic acid. Four hours incubation of the enzyme extract with glucose at *p*H 6·5 and in presence of added manganese produces the following results.

Source of enzyme	% Mn in incub. mix.	Ascorbic acid synthesis (mgm./gm. fresh tissue)	
		Without dialysis of enzyme extract	After electro-dialysis of enzyme extract
Goat jejunum	nil	0·02	0·01
,, ,,	0·004	0·06	—
,, ,,	0·01	—	0·06
Guinea pig jejunum	nil	0·015	nil
,, ,, ,,	0·005	—	0·035

The protein fraction precipitated at *p*H 5·7 is inactive, but attempts to concentrate further the enzyme by separating the globulin fraction failed because both the globulin fraction and the albumin fraction partially retained the enzymic activity. It also appears that the coenzyme (Mn) is more firmly attached to the enzyme in animal intestines than in the germinating grains. In the latter, electrodialysis for half an hour of the enzyme extract suffices to inhibit the activity, while in the former, even an hour fails to arrest the activity completely.

The investigation is proceeding.

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Flocculation of Bacteria by Protozoa

IN view of the recent discussion[1,2] of the possible importance of certain Protozoa in the flocculation of bacteria in sewage sludge, it may be of interest to record a clear-cut instance of flocculating activity on the part of a protozoan.

The ubiquitous freshwater and soil flagellate *Oikomonas termo* Kent, when grown in two-membered culture with various bacteria, has been observed to cause a very marked flocculation of certain species, notably *Erwinea carotovora*, *Erw. phytophthora*, *Proteus vulgaris*, *Phytomonas tumefaciens* and one strain of *Escherichia coli*, to use the nomenclature of Bergey's "Manual"[3]. The medium used for these mixed cultures contained 0·2 per cent glycerol, 0·1 per cent Difco proteose peptone, and 0·02 per cent each of calcium chloride and magnesium chloride. In tubes containing 10 ml. of this medium, flocculation usually occurred within three or four days after the introduction of small inocula of the bacteria and the protozoa. Microscopically, each of the floccules was seen to consist of a large central mass of bacteria with a few flagellates attached at the periphery. The maximum diameter of these floccules was about 3 mm.

Since both the bacterial and the protozoan cultures[4] used for the inoculations were pure cultures, and since the bacteria when grown alone in this medium flocculated very slightly, and then only in old cultures, there can be little doubt of the causal significance of the protozoan. The mechanism of the flocculation has not, however, been investigated.

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[1] Jenkins, S. H., NATURE, 150, 607 (1942).

[2] Pillai, S. C., and Subrahmanyan, V., NATURE, 150, 525 (1942).

[3] Bergey, D. H., *et al.*, "Manual of Determinative Bacteriology", 5th ed. (Baltimore, 1939).

[4] Hardin, G., *Physiol. Zool.*, 15, 466 (1942).

Long-Chain Molecules in Aqueous Urea Solution

FRICTION between surfaces is normally either of the (*a*) continuous or (*b*) stick-slip type. Occasionally, however, as in the determination of the viscosity of ammonium oleate solution by means of the concentric cylinder method, a new type (*c*) is encountered provided the shearing-rate is sufficiently low. In this, chain-like micelles cause adhesion between the surfaces, this adhesion being then periodically broken down with violent movements.

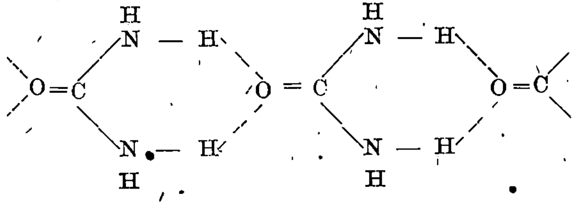
In the course of some experiments on friction utilizing an apparatus similar in principle to that previously described[1], in which a tungsten wire attached at its two ends by springs is half wrapped round a rotating 'Perspex' wheel partly immersed in a liquid, it has been found that friction of types (*a*) and (*b*) is encountered with by far the greater proportion of the aqueous solutions so far investigated. A solution of ammonium oleate exhibiting anomalous viscosity, however, gave rise to violent periodic movements of the wire (friction of type *c*). Using this apparatus, it has been found that while 2 per cent aqueous urea gives friction of type *a*, 20 per cent gives type *c*. The violent oscillations thus caused are sensitive to *p*H changes, being completely stopped by a few drops of dilute acetic acid.

The occurrence of *c*-type friction may most readily be explained on the hypothesis that strong urea solutions contain chain-like molecules which collect together to give fibrils of considerable mechanical strength. The formation of chains is not unlikely in view of the fact that hydrogen bonding is known to occur with complex substituted ureas in monolayers and to be destroyed by acidification (Alexander[2]). It would appear that the simple apparatus used in this work, of which it is hoped to publish further details shortly, may prove of value in detecting chain molecules in solutions. A similar effect has also been observed in the case of a saturated solution of glycine.

A solution exhibiting anomalous viscosity often shows the properties of a weak solid, so that floating objects, after having been rotated on its surface, will then 'unwind' of their own accord (Hatschek[3]). Experiment has shown that small objects floating on saturated urea solution will very slowly 'unwind' up to about 15°, which again affords strong evidence of the existence of molecular chains in the solution The effect is much reduced by acidification.

Saturated aqueous urea has also been found to exhibit a strong Tyndall effect, as does also molten urea at its melting point, thus confirming the presence of large molecules.

If, as seems likely (Pauling[4]), hydrogen bonding creates a new very large dipole moment, it is possible that, bonding having once started, a chain will continue to grow in length through the solution so that finally, although most of the molecules may be monomeric, a small proportion may be very highly associated. Numerous formulæ for such chain molecules are possible, the following being, perhaps, as likely as any :



In such a chain, on Pauling's view, there would exist a series of dipoles, while the two ends of the molecule would be charged. The intermediate dipole charges would cause strong lateral attraction between similar chains displaced a few Ångström units with respect to one another, while the end charges may serve to attach the chains to solid objects or other similar interfaces. In this way the *c*-type friction and the Hatschek effect find a ready explanation.

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May 8.

[1] Clark, R. E. D., *J. Soc. Chem. Ind.*, 59, 216 (1940).

[2] Alexander, A. E., *Proc. Roy. Soc.*, 179, A, 470 (1942).

[3] Hatschek, E., *Proc. Roy. Inst.*, 25, 251 (1927).

[4] Pauling, L., "The Nature of the Chemical Bond" (1939).

A New Type of Complex Silver Compounds with Tervalent Silver

In course of a series of investigations[1] in this laboratory on the complex compounds of biguanide and substituted biguanide with metallic elements, recently my pupil, K. Chakravorty, and I, have obtained a number of 4-co-ordinated silver ethylenebiguanide salts in which the central silver atom shows, rather strikingly, a primary valency of three. Their composition is given by

$$[\mathrm{Ag^{III}}\,(\mathrm{EnBigH})_2]\,X_3,$$

where X is SO_4, NO_3, ClO_4, or OH; and EnBigH is one molecule of ethylenebiguanide ($C_4N_5H_9$), which behaves as a chelate or bidentate molecule. The salts form beautiful, needle-shaped, prismatic crystals of deep red colour and are quite stable at ordinary temperature (20°–24° C.). The nitrate can be recrystallized from warm dilute nitric acid. The colour of the base is dark violet-red resembling that of potassium permanganate.

From an acidified solution of potassium iodide the complex ion liberates *two* equivalents of iodine for every silver atom. The molecular conductivity of the nitrate at 20° C. is 455 ohms^{-1} at infinite dilution, as would be expected for a tervalent complex ion. The salts, unlike those of bivalent silver, are *diamagnetic*.

The electronic configuration of a tervalent silver atom should be similar to that of bivalent nickel, just as bivalent silver is analogous to bivalent copper. Hence t is not at all surprising that the four-co-ordinated ervalent silver complex shows diamagnetic character, if the co-ordination bonds be of the hybrid d-s-p^2 type as in the corresponding planar bivalent nickel complexes. In fact, the diamagnetic property of these omplex salts furnishes a strong confirmation of the tervalency of silver in them. That a tervalent silver gives a co-ordination number of four, and not six which is the characteristic of a large number of other tervalent ions, is quite in keeping with its position between copper and gold in the same group of the Periodic Table. A tervalent gold, as is well known, shows consistently a co-ordination number of four with planar configuration. There is, therefore, nothing unusual in that the silver atom shares the character of both copper and gold, becoming uni-, bi- and tervalent respectively.

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[1] Rây and co-workers, *J. Indian Chem. Soc.*, 671 (1937); 347, 350, 353, 633 (1938); 621, 629, 617 (1939); 217, 289, 298, 609 (1941); 1 (1942).

The Concept of Polygenes

In spite of Waddington's[1] clear statement to the contrary, the recent correspondence[2,3] on polygenes tends to create the impression among biologists who are not geneticists that polygenes are a new development. It is worth pointing out, therefore, that not only is the concept traceable to Mendel himself, but that the very word "polygene" (equivalent to the English adjective) appears to have first been used extensively by Plate in his 1913 text-book[4]. The word did not meet with general approval at the time, and indeed objections against it very similar to Waddington's[1] were made by that pioneer of quantitative inheritance, Johannsen[5]. Thus on page 669: "Darum ist es auch unzulässig von 'monogenen' oder 'digenen' Merkmalen, als Gegenstück zu (polygenen) Merkmalen zu reden, wie Plate es neuerdings tut. Selbst im populären Abhandlungen dürfen solche prinzipiell unrichtige, eigentlich nur auf Zufälligkeiten der unvolkomenen Kreuzungsanalysen sich beziehende Ausdrücke nicht verwendet werden, weil sie ja nur verwirren können. Es steckt darin ein Rest veralteter Vorstellungen über 'Merkmahle' und deren einheitlich 'Anlagen',—wir müssen aber wirklich aus dem Banne diese Konzeption heraus", and a similar paragraph on p. 561.

Such words are at times convenient, and if their use is not to be accompanied by the kind of misunderstandings mentioned by Waddington[1] it is essential that the underlying fallacies be clearly seen. As the last-named author points out, the fallacy in the use of the nouns polygene and oligogene is the disregard of pleiotropic gene action. The corresponding adjectives imply a converse fallacy, namely, that characters are determined by one gene only.

As Mather[3] states, his point of view differs from that of Nilsson-Ehle. It is, in fact, much more similar to that of Johannsen and of a number of others. Present-day work only differs from that of these early pioneers by its insistence on natural selection and by the idea that linked complexes will be built up through its operation, an idea put forward by Fisher[6]. The actual experimental demonstration of linked complexes is still in its infancy.

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May 16.

[1] Waddington, C. H., Nature, 151, 394 (1943).

[2] Mather, K., Nature, 151, 68 (1943).

[3] Mather, K., Nature, 151, 560 (1943).

[4] Plate, L., "Vererbungslehre" (Leipzig, 1913).

[5] Johannsen, W., "Elemente der Exakten Erblichkeitslehre", 2nd ed. (Jena, 1913).

[6] Fisher, R. A., "The Genetical Theory of Natural Selection" (Oxford, 1930).

RESEARCH ITEMS

History and Ethnology of the Caddo Indians

THE Caddo Indians, of whom very little has been written, were a group of tribes of great importance in the earliest days of which there is historical record in America, that is, in the first half of the sixteenth century. But they have been almost lost to sight and their significance underrated because they lived in a portion of the country beyond the Mississippi that was not under the control of the United States. The early records of this stock are in Spanish and French, and by the time the United States took over the territory these Indians were scattered and their culture practically destroyed. The assembling, therefore, of the materials for this study was of great importance, and the results (John R. Swanton, *Bull.* 132, Bur. Amer. Ethnology, Smithsonian Inst.) form a valuable addition to the literature dealing with the American Indian.

Death-rate Variation in Fowls and Geographical Latitude

IN order to study the rate of embryonic mortality in fowls and factors determining it, investigations were made at the Moscow Institute for Poultry Breeding by E. Penionzhkevich (*C.R. Acad. Sci. U.R.S.S.*, 32, No. 8; 1941) on 61 million eggs from 369 farms situated in latitudes ranging from 42° to 62° N. It was found that the embryonic death-rate increases (that is, the hatching-rate decreases) with latitude, and the regularity holds good for two consecutive years, the difference in the mortality-rate averaging 6 per cent. When the mortality-rate was analysed with regard to the stage in the embryonic development, it was found that the increase of mortality in more northern latitudes is particularly due to the environmental influence, not in the first seven days of development, but during the following period up to hatching. The rate of embryonic mortality, according to the author's theory, is due to the influence of the environment not on the egg itself but on the maternal organisms.

Identification of Clostridia of Gas Gangrene

G. F. Petrie and D. Steabben (*Brit. Med. J.*, 1, 377; March 27, 1943) have shown that colonies on agar plates of the three chief pathogenic clostridia of gas gangrene—*Cl. welchii*, *Cl. septicum*, and *Cl. œdematiens*—can be identified with certainty if the corresponding antitoxin is added in an optimum amount to the basal medium, which is chosen as one that favours production of the specific toxin. During anærobic incubation the toxin diffuses from the colony and interacts with the antitoxin to produce an easily recognizable precipitate, which resembles a halo round the colony and which consists of toxin-antitoxin aggregates linked together. This precipitate tends to form concentric (Liesegang) rings that are so characteristic as to leave no doubt of the identity of the associated bacterial species. In the authors' view the most likely explanation for the appearance of concentric zones is that the forces which combine to build up the framework of molecular aggregates as a uniform deposit to the naked eye are not in equilibrium, and that at a later stage stresses or strains in the structure result in condensation of the precipitate in the form of annular zones separated by clear zones. The remarkable symmetry of the concentric zones is evidence that the molecular aggregates which constitute the toxin-antitoxin precipitate within the matrix of the agar gel are disposed in an ordered arrangement and that the forces controlling them are in equilibrium. The method may prove to be useful in the investigation of the anærobic flora of wounds and for the diagnosis of gas gangrene in time of war.

Alighting-Boards and Colour-sense in Bees

THE *Bee World* of March 1943 contains a translation of an article by Dr. Ruth Lotmar, published in the *Schweizerische Bienenzeitung* of October 1942, entitled "Painted Alighting-Boards and the Colour-Sense of Bees". The use of coloured alighting-boards is advocated as a measure for preventing excessive drifting of bees which may result in the carriage of disease from infected to healthy stocks. It appears desirable, therefore, to enable the bees to find their own hives more readily by marking the alighting-boards distinctively. In order to do this to best advantage, it is necessary to make full use of the available knowledge regarding the colour reactions of bees. It is recommended that the following principles be observed in painting alighting-boards. Strong dark colours should be used. Although bees are red-blind, colours with red in them can be used. Thus, cinnabar and purple-red can be used because these colours appear to the bees as dark brown and dark blue respectively. They should not be used, however, to compete with alighting-boards painted with the last-named colours. If white paint be used it is desirable to adopt as pigment zinc white in preference to white lead. White surfaces, seemingly alike to human vision, may look very different to bees according to the amount of ultra-violet in their composition. Thus, the artist's pigment white lead which scatters much ultra-violet appears white or pale grey to bees. But zinc white, Titan white, etc. scatter little or no ultra-violet and are seen by bees as intense blue-green. It is the latter type of white that is to be preferred. Since bees are able to distinguish between different degrees of brightness of a given colour, different tones of the colour may be used but it is preferable that two neighbouring hives be painted in different colours. While young bees leaving the hive for the first time, often drift into neighbouring stocks, their return to their own hives can be made much easier by the suitable painting o the alighting-boards.

Head Musculature of Coleoptera

UNDER the title "The Musculature of the Labrum Labium and Pharyngeal Region of Adult and Immature Coleoptera", C. K. Dorsey contributes a detailed morphological study which forms No. 7 vol. 103, of the *Smithsonian Miscellaneous Collection* (January 1943: Publication 3,697). The object of this study is to discover the arrangement of th muscles of the parts concerned and their bearing upon the process of food ingestion: also it is intended to serve as a contribution towards determining muscle homologies between different groups o insects. The author concludes that it is difficult and often impossible to identify corresponding muscles on a functional basis. A muscle, for example, may be an adductor in one species whereas its homologue in another species is perhaps a retractor because of some slight change in the position of the point of insertion It is considered for this reason that the general application of functional names to insect muscles i limited. The 24 plates illustrating this paper con prise 134 figures of the muscles concerned in a very wide range of Coleoptera and their larvæ. The Leng system of classification as modified by Böving and Craighead is followed, and at least one family from each superfamily selected from which a genus is chosen for study. When possible, the immature stage of the same genus is used.

Early Collections of Arctic Plants

Between the years 1819 and 1825 three voyages were made by Parry in search of the North-West Passage. On all these expeditions Parry and his officers made collections of plants. While some of these were intended for institutions and have long been available for consultation, other sets were probably made up for presentation to personal friends. Four small sets, perhaps all of which belong to this category, form the subject of an article by Dr. N. Polunin (*North Western Naturalist*, Sept. 1942). Three of the sets are in the Manchester Museum and one at the University of Durham. There is evidence that W. J. Hooker and Robert Brown, in preparing their accounts of the botany of the areas covered by the expeditions, had not seen all these collections, though the additional records which they furnish have been reported by later collectors. Three of the collections appear to have been made on Parry's third voyage; the remaining one, though labelled as coming from the first voyage, contains some species which were almost certainly collected on the second. Except for one set the collections are of little value for purposes of phytogeographical citation owing to the absence of localizations on the individual sheets. The most interesting species represented is *Salix polaris*. There is no satisfactory evidence for the occurrence of this species in the Canadian Arctic Archipelago, and in view of Parry's visits to other Arctic regions where the species abounds it cannot be safely admitted on the basis of this unlocalized specimen.

Autonomic Leaf Movements and Water-Balance in the Plant

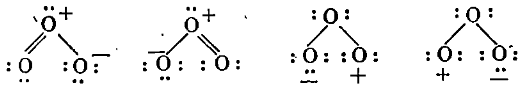
The half-yearly *Journal of the Mysore University* (3, No. 1, September 1942) contains some interesting observations by C. V. Krishna Iyengar on autonomic leaf movements, and their relation to the water-content of the plant. They were studied particularly in *Desmodium gyrans*, *Mimosa pudica* and a species of Impatiens, but such autonomic movements are seen not only in these plants but also in many leaves with or without pulvini. The petiole shows the movement whether the lamina is present or removed, and the direction and rate of leaf movement resulting seem to be determined by the water content of the plant. Experiments indicated the occurrence of movements due to major and minor fluctuations in the water balance, major fluctuations occurring at intervals of 10–20 minutes, minor at shorter intervals of one minute or less.

Flame Spectra in the Photographic Infra-Red

The spectral region between 7,000 and 10,000 A. has been neglected owing to the weakness of flames as sources and the slowness of photographic plates in this region. A. G. Gaydon (*Proc. Roy. Soc.*, A, 181, 197; 1942) has photographed in the range 6,000–10,000 A. the spectra of the flames of hydrogen, methane, and carbon monoxide burning with oxygen and with nitrous oxide. All flames in which water is a final product show a system of emission bands from the red to the far infra-red, the bands increasing in strength to longer wave-lengths. Outstanding bands were identified as due to the vibration-rotation spectrum of H_2O. The top of a flame of oxygen burning in hydrogen is coloured red by the emission of these bands. In the hydrogen flame the bands are probably excited mainly thermally, but the strength of these same H_2O bands in the flame of moist carbon monoxide indicates that in this flame the excitation is a result of the combustion processes. In the hydrogen – nitrous oxide flame, new band structure in the infra-red is provisionally assigned to an extension of the ammonia α band. The methane–nitrous oxide flame also shows the ammonia α band, and in addition strong emission of the red system of CN.

Molecular Structure of Ozone

Discussion has recently centred about the question whether the ozone molecule is triangular or a bent rod. The angle proposed for the bent molecule has varied from 38° to 140° and the interatomic distance from 1·13 to 1·29 A. An investigation of the electron diffraction of ozone by W. Shand and R. A. Spurr (*J. Amer. Chem. Soc.*, 65, 179; 1943) leads to the conclusion that the molecule is in the form of an isosceles triangle with the O to O bond distance 1·26 ± 0·02 A. and the O—O—O angle 127° ± 3°. Resonance between the structures:



is assumed, although the angle is slightly larger than would be expected. The angle recently calculated by C. P. Smyth and G. L. Lewis (*J. Amer. Chem. Soc.*, 61, 3063; 1939) is much larger, 140°, and in a note added to their paper, Shand and Spurr mention that Mulliken has recently favoured, from spectroscopic evidence, a triangular molecule with the angle of 39°. It would seem that the structure of ozone is still problematical.

Rare Earths

A convenient method for the separation of ytterbium from the neighbouring rare-earth elements is described by J. K. Marsh (*J. Chem. Soc.*, 8; 1943). A hot solution of ytterbium acetate on treatment with sodium amalgam was first reduced to an orange-yellow solution containing bivalent ytterbium, and then ytterbium amalgam was formed. The reaction is almost quantitative. The neighbouring elements are devoid of amalgam-forming power. After treatment of the amalgam with acid and precipitation and ignition of the oxalate, ytterbium oxide spectroscopically pure was obtained. The purification of a lutecium preparation by removal of ytterbium as amalgam, in presence of added samarium acetate, is described. The same author (*ibid.*, 40) describes some yttrium group oxalates. In the cerium group the common oxalate is the 10-hydrate, but some 9- and 11-hydrates are known. In the yttrium group the recorded results are more diverse, but 6-, 10- and 17-hydrates of yttrium oxalate have been prepared, the first two being new, and the last peculiar to yttrium. The 9-hydrate reported is actually a complex ammonium salt. The 6-hydrate of ytterbium oxalate was prepared.

SEWAGE TREATMENT IN A TROPICAL CITY

By Dr. Ll. Lloyd
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MR. N. V. MODAK has given an account of the operation of a sewage purification plant at Dadar, Bombay, the first city in India to operate such works under skilled technical and scientific supervision with the requisite laboratory control (Presidential Address, Section of Engineering and Metallurgy, 30th Indian Science Congress, Calcutta, 1943). The works, constructed in 1934, receive 10 million gallons a day, of which half is fully treated and the rest passed into the storm channels after settlement, the War having prevented proposed extension. The plant includes a Simplex activated sludge system, an enclosed bacteria bed with forced aeration and a sludge digestion chamber with gas recovery. It has been in operation sufficiently long for certain peculiar problems of sewage purification in the tropics to be realized. Special difficulties are experienced in dealing with the grit and with the septicity which prevails at all seasons in the initial tanks and readily develops in the later parts of the system.

The sewage contains road grit only after great storms, but the general habit of scouring pans with ashes and dust introduces a steady quantity of grit into the domestic sewage. A fault in design complicates the matter, for the screens are down flow from the grit chambers and so the inorganic matter becomes inextricably mixed with rag, fæcal material and cellulose waste to the extent of 40 per cent. The grit in the most septic state has to be removed four to six times a day, as opposed to the English practice of after storm. The material removed is an offence and a source of fly breeding (these flies will include the dangerous domestic species) and as no means of washing or incineration are available, it has to be transported far from the city.

The prevailing septicity complicated the operation of the sedimentation tanks. Detention in hopper-bottom Dortmund type tanks could last only 1½ hours (a general minimum of 8 hours is desirable) and the tanks had to be desludged every two hours in dry weather, every four hours in wet weather. In England a weekly cleansing suffices. A radial flow circular tank gave rather better results, but the scraper had to work continuously instead of the normal intermittence to prevent the septic solids from adhering to the sides. No chemical treatment was afforded at any stage. Judicious chlorination after the screens might have counteracted the tendency to putrefaction and simplified later operations.

It took about a year of experiment and adjustment to obtain satisfactory results from the activated sludge plant. Septicity was again a difficulty, as attempts to consolidate the sludge for injection rendered it corrupt. In the sequel the injected sludge contained 99·5 per cent water as against a normal 98·5 per cent. The volume of surplus sludge was enormous, 2 million gallons a day being produced from the 4 million gallons a day flow. This difficulty was overcome by devoting six tanks (out of eighteen) to consolidation for a 6-hour period, by means of which the sludge for disposal was reduced to a twentieth of its bulk. Mr. Modak claims that this is an innovation worthy of general adoption. The fauna typical of high-quality activated sludge developed only during the monsoon, though the system seems to have given fair results once the local conditions were mastered; but it was hypersensitive.

The enclosed percolating filter with forced draft is of particular interest as such plant is still a novelty. The design is calculated to reduce stench and fly escape, a matter of the greatest importance where intestinal diseases are rife. The filter was 78 ft. 6 in. in diameter and 7,000–12,000 cu. ft. of free air per minute was driven in through the cone-shaped roof. Windows were provided but proved useless owing to sewage spray and resulting growths. Internal lighting was therefore installed. The filter was 12 ft. in depth (against a normal 6 ft.) with the idea that more work would be done in a restricted area (but modern belief is that the main purification takes place in the topmost foot and stabilization through nitrite to nitrate below). Actually, nitrate never developed and it is likely that the normal 6 ft. depth would have given equal results. The expectation was that the filter would deal with a flow of 2 million gallons a day, but it would cope with no more than half this load. At the higher flow it went out of action with the loss of its scouring fauna, and then would not deal with 1 million gallons a day but had to be stopped, cleaned and restarted *de novo*. The scouring fauna consisted of earthworms, small wriggling pink worms (probably enchytræid) and the usual psychoda flies. Several slight modifications are suggested mainly to reduce escaping odours. Work inside such a chamber in the tropics, the inevitable cleaning of the tubes and jets, must be the intensest strain.

This enclosed filter is preferred for Indian conditions to the activated sludge system for the following reasons: (1) It requires 15–18 h.p. per m.g. whereas activated sludge process requires 28–35 h.p. per m.g. (2) The mechanical attention required is much less and the mechanism is less complicated. (3) Skilled supervision is not constantly required due to non-sensitiveness. (4) Manual labour required for its upkeep is less. (5) For equal capacity plants the area required for an enclosed filter is almost half of that required for activated sludge plant.

The sludge digestion chamber yielded 60,000 cu. ft. per day (0·7 cu. ft. per person contributing; 65 per cent methane). Only 25 per cent of this output was utilized and the rest burnt, though some useful outlet for the surplus is being sought. In this connexion the present writer has wondered whether it would be feasible to utilize recoverable gas for steam-pressing sludge. Sludge is a valuable fertilizer, but is intractable because of its water content with which it will not readily part, and vast quantities are dumped into the sea or spread in barren lagoons to the waste of valuable land. So we fritter away our heritage. Sometimes it is cold pressed, but the product is in lumpy cakes and though accepted as fertilizer it is difficult to spread and disintegrate. At the Esholt Works of Bradford City Corporation, sludge is steam pressed for the recovery of grease from the wool washings, part of the recovered grease being utilized to raise steam. The resulting material is not sludge but a friable humus of sufficient value to be shipped in considerable quantities to France and even Palestine for horticultural manure. Such steam pressing would render tropical sludge safe for truck crops whereas it is dangerous untreated, for the eggs of intestinal helminths must remain viable during passage through the works and some species remain viable for years. At Dadar little sludge is utilized for manure, the amount sold being valued at only Rs. 100 in the year.

Mr. Modak's important address suggests several lessons. Bombay has gone ahead of some of the seaside resorts of Great Britain, where it is still the practice to pour untreated sewage into the sea, to the fouling of the foreshore and the discomfort and danger of bathers—although some visitors confuse the sewage smell with that of ozone. Bombay started late and so had the advantage of the great body of research work that has been put into sewage purification in recent years. Much study preceded the choice of plant, and what appeared to be the best was chosen. Yet without the scientific staff and full laboratory facilities (in charge of Mr. Y. N. Kotwal) the institution of the works would have been a disaster for the city, the works being in a residential area. The special local conditions have demanded much study and adaptation to reduce stench and fly breeding. There is no lesson for the man of science in this, but there is one for the town and city councillor. Crude sewages look much alike, but in fact are vastly different and each new industry changes the character to some extent. Each type calls for study and research in local conditions if the best is to be got out of the plant. The authority should therefore not think that when system and labour are provided there shall be no further spending. Sanitation in any of its forms calls for constant scientific guidance and searching for improvements and economies.

Mr. Modak's closing words are worth repeating. "Sewage disposal is a universally repugnant subject and the public conclude that a sewage treatment plant cannot but be a place of foul odours and obnoxious sights, a place only fit for scavengers, a place that must be avoided by respectable persons. A well arranged, clean and landscaped sewage works with trees and lawns has a favourable psychological effect on the workers and visitors. The public will then know that, at a sewage treatment plant, even men, both clean and intelligent like themselves, are working, doing an important job and recovering useful products from human waste." The present writer visits one such place in Yorkshire where broad, gently curving walks are bounded with trees and easy seats, where there is no odour or annoyance from flies. There it is a pleasure to sit and restful to watch he spraying arms move slowly on their inevitable way.

ANTARCTIC RESEARCH

THE most recent volume of the Discovery Reports* contains a station list which is a coninuation of that already published in the reports, ols. 1, 2 and 4, and gives particulars of the observaions made by the R.R.S. *Discovery II* from October 931 to April 1933. To the usual hydrological data re added, in part, phosphorus, nitrate plus nitrite, itrite and silica estimates.

The porpoise described by J. E. Hamilton was in practically skeletal condition and the paper relates o the skull, ribs, sternum and vertebral column.

The Echiuridæ, etc., by A. C. Stephen has already been reviewed in NATURE (149, 57; 1942).

The remainder of the volume contains Dr. Hart's valuable monograph on Antarctic phytoplankton. Following his former work ("On the Phytoplankton of the South-West Atlantic and the Bellingshausen Sea, 1929–31", Discovery Reports, 8; 1934) it amplifies this enormously, and the whole scope of the work during the earlier commission is greatly enlarged with the expansion of modern whaling during 1928–31, and after. His present work covers a vast area, his aim being to provide a picture of the major differences in phytoplankton distribution at different times of the year throughout the whole of the Antarctic zone of the Southern Ocean. It is very satisfactory that his earlier predictions have been in most cases fully confirmed.

This research, necessarily limited in scope, deals mainly with the larger qualitative and quantitative differences in the phytoplankton, at as many stations as possible, and the changes throughout the year in single areas where conditions seem to be typical. To facilitate this study the author divides the Antarctic zone into regions and special areas based mainly on the degree of neritic influence and the northward extent of the Antarctic surface waters in the longitudes concerned. The diatoms themselves, much the most important of the phytoplankton organisms, are grouped on a system taking into account their general distribution, seasonal and geographical.

Although a certain number of counts with centrifuged samples were made, by far the greater part of the work was done by the estimation of pigment contents of the catches by Harvey's (1934) method, the results being expressed in arbitrary colour units per cubic metre and the catches from 50 m. to 0 m. made with a vertical net fitted with a meter recording the volume of water filtered—a method which was found most effective.

Polar conditions extend much farther towards the equator in the southern than in the northern hemisphere and there are great differences in climate and hydrological conditions. Antarctic surface waters are much richer in nutrient salts and in phytoplankton. In corresponding latitudes the main increase is relatively later. Light, the degree of stability of the surface layers and the interrelated effects of pack ice, appear to be the most important factors in determining the course of phytoplankton production within the Antarctic zone, but the post-maximal summer decrease in the more northerly Antarctic waters and the very much greater production in neritic as compared with oceanic areas must probably be explained by chemical and biological factors. Here the reduction of silicate in the more northern parts of the Antarctic zone is a likely cause of decrease in diatoms, and the immense numbers of fæcal pellets of diatom-eating animals which accompany the comparatively poor phytoplankton during the decrease suggests that heavy grazing by the zooplanktonic herbivores was in part responsible and possibly the most important biological factor influencing production. The much greater richness of diatoms in the neritic areas as compared with the oceanic regions offers a different problem and here there may be, as suggested by Hardy, backed by a certain amount of evidence, the converse of grazing—that of animal exclusion. It is possible that the enormous masses of diatoms exclude the presence of zooplankton. To account for these huge masses of neritic diatoms recent work tends to show that extremely small amounts of organic compounds, iron and manganese, derived from the land, exert a strongly favourable influence on phytoplankton production.

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* Discovery Reports. Issued by the Discovery Committee, Colonial ffice, London, on behalf of the Government of the Dependencies of e Falkland Islands. Vol. 21 (1942). Title Page and List of Contents. tation List 1931–1933 (1941). A Rare Porpoise of the South Atlantic, *hocaena dioptrica* (Lahille 1912) by J. E. Hamilton (1941). The chiuridæ, Sipunculidæ and Priapulidæ collected by the Ships of the iscovery Committee during the Years 1926 to 1937, by A. C. Stephen 941). Phytoplankton Periodicity in Antarctic Surface Waters, by John Hart (1942). (Cambridge: At the University Press.)

The importance of the pack-ice in maintaining the flora within the Antarctic zone is much emphasized. It is even more marked than earlier observations suggested. By means of the pack-ice neritic species are maintained very far from land and flourish for short periods when the ice disperses.

It is here confirmed, as is already noted by former observers (Marshall, Gross and others), that Calanoids are capable of triturating and swallowing the larger spiny diatoms as well as ingesting the smaller species entire. The author's examination of stomach contents showed that in addition to *Euphausia superba*, other Euphausiids, some of the most important Calanoids and some of the more abundant Pteropods, all feed extensively on diatoms.

INTERNATIONAL LAW AND MORALS

PROF. MORRIS GINSBERG wisely chose for his presidential address to the Aristotelian Society* a theme relevant both to his own distinguished work as a sociologist and to the world crisis which perforce dominates public attention at the present time. He sets himself to show how the trend towards an individualist doctrine in ethics is discernible also in recent developments of international law, attended there by "a certain lag in applying the criticisms which in the course of the nineteenth century were directed against the principles of individualism" (for example, the right of property and freedom of contract) in the internal economy of States, to the problem of the relations between States, a lag that is in no small measure responsible for our present international troubles and calls urgently for rectification. The only remedy, he contends (and the contention is supported by much judicious illustration), lies in the establishment of an effective supra-national authority. It makes little difference to this conclusion whether a utilitarian criterion or a doctrine of natural rights be adopted as the basis of the theory of international law; for the advocates of both these positions have carried the individualist interpretation to an extreme that precludes any satisfactory solution of international problems. Prof. Ginsberg's discussion of the concepts of equality, freedom and self-determination and of the difficulties provoked by each when held to be natural rights is perhaps the most masterly section of his address.

Three points in his review call for special notice. Not only is he convinced that the problem of international relations is a moral one; but it is so regarded by public opinion, both at home and, as has erroneously been questioned, in enemy countries. Nazi propaganda has won its way in Germany by an appeal to justice and denunciation of the alleged injustice of which Germany has been the victim. The theorists of the movement "even go to the length of claiming that they have bridged the gulf between law and morals and that their law alone is *richtiges Recht*". It is vitally important for us all to realize that the conflict in which we are engaged is being fought out on ethical terrain by both sides. It is a conflict of one set of moral principles against another.

Secondly, on both sides, the ethical concept of justice is in the forefront. Prof. Ginsberg follows Sidgwick in holding that the principle of seeking happiness needs supplementing by that of just distribution. So, again, there can be no peace among the nations without justice, and justice implies positive co-operation for common ends. Lastly, he has some interesting remarks towards the close on the error, into which many thinkers on politics have fallen, of presenting the issue now before the world as whether the individual exists for the State or the State for the individual. To posit the antithesis thus is to over-simplify the real problem. "There is clearly a need," he says, "for a great variety of corporate bodies to mediate between the mass of individuals and the community of mankind." This need is increasingly urgent in the larger among modern States, and is winning recognition in federal communities like the British Commonwealth, the American Union and the U.S.S.R. A great deal of the work of self-government is carried on, not within the bounds of constitutional machinery (where the individual citizen scarcely counts, even when he is voting), but through participation in non-official groups, churches universities and learned societies, professional organizations and trade unions.

We are duly grateful to Prof. Ginsberg for directing attention to the part such groups may play in the solution of international problems.

W. G. DE BURGH.

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*"The Individualist Basis of International Law and Morals", by Morris Ginsberg, being the Presidential Address to the Aristotelian Society, 1942–3.

CIVILIAN CONTRIBUTION TO EDUCATION IN H.M. FORCES

THE report of the Central Advisory Council for Adult Education in H.M. Forces for the period April–September 1942 reflects great credit on all the civilian authorities who constitute the Centra Advisory Council. The launching of the educationa scheme in the Forces could scarcely have been possible without the active participation of the Central Advisory Council, while any success it may have achieved is due in large measure to the substantial assistance provided by the regional committees of the Central Advisory Council in the various administrative areas. It is early yet to assess the real worth of this tremendous educational experiment, but already there is sufficient evidence to show that, by means of talks and discussions on various aspects of citizenship, those who have been responsible for the development of education in th Fighting Services have done much to develop a sense of civic awareness and responsibility among the people who are the potential citizens of Grea Britain. Despite the difficulties of travelling in th black-out, the geographical isolation of Army and Air Force units, the cancellation of lectures at shor notice owing to military exigencies and other factor which give rise to a considerable amount of exasperation and frustration, civilian lecturers have steadily continued to offer their services under the Scheme fo Education in H.M. Forces. The statements in thi report bear testimony to their achievements.

An analysis of the statistics brings out some interesting observations. During the period unde review (April 1942–September 1942) the Centra Advisory Council arranged some 44,695 singl lectures, 2,513 short courses (average, 5 meetings), and 1,030 continuous classes of longer duration (average, 13 meetings). A comparison of these figures with those of the preceding six months (29,970 single lectures, 1,785 short courses and 1,097 classes), indicates the progress of the scheme. It should be mentioned that these figures do not include lectures and classes arranged by local education authorities direct with the Services.

As one might expect, the greatest number of these lectures, etc., were given to Army units, but it is encouraging to note the increase in number of lectures to the Royal Air Force and the Navy. It is impossible to obtain accurate figures to show how much advantage is taken by the Women's Services of the regional committee facilities because there is no way of ascertaining the number of women attending in mixed audiences. But there is little doubt that the educational scheme has 'caught on' with the women auxiliaries, and this is clearly indicated by the figures set out in the report for all-women facilities.

A survey of the subjects which were discussed at these lectures and classes shows, as one might expect, the single lectures on current events are mostly in demand by the troops (29,419 out of a total 39,031). Science lectures are divided into two categories, vocational and non-vocational, and provided 264 and 2,287 lectures respectively ; psychology is listed as a separate item and accounted for 493 lectures. There were 979 single lectures on arts subjects.

As in single lectures, current affairs were much the most popular choices in the short courses (1,664 out of 2,420), but the outstanding feature here is the interest shown in short courses on music (135 out of a total of 2,420). Among the classes, languages were mostly demanded (334 out of 970) while handicrafts (272) were also in favour. Vocational cience classes were quite popular (131), but there was little demand for non-vocational science (12 lasses only).

Some doubts are expressed as to whether the egional committees will be able to meet the increasing emands being made upon them. But for the time eing, at least, this problem seems possible of solution y the more effective use of already existing panels f lecturers. The appointment of more full-time ecturers to the regional committees would do much o ease their difficulties.

CHEMICAL ATTACK UPON PESTS

N time of war, man becomes pest- and disease-conscious. Under its abnormal and stringent onditions, leading to overcrowding and lack of igilance, he, his domestic animals, his food plants, nd to some extent his very clothing may become more susceptible to attack by pests and disease. War and pestilence interlock, but with increasing cientific knowledge we have ceased to regard the atter as an act of God before which we are powerless. ince the War of 1914–18, there has probably been greater advance in the development of pest and sease control than in all past history. Much of his progress undoubtedly has been due to extensive nd intensive co-operation of biologists and chemists. he early triumphs of chemotherapy gave an impetus o research outside the purely medical field, which as based upon the belief that in chemistry there existed a potential arsenal that might well be turned to account for purposes of pest control.

In a paper read before the Royal Society of Arts on March 31, Dr. R. E. Slade developed in the simplest language the story of the chemical methods now used for this purpose. Although almost any modern allotment holder knows the way, and possesses the means, of controlling many of the pests preying on his plants, a lecture of this type serves a most useful purpose in giving to the general public a co-ordinated account of a very large part of this field of research and in showing by implication how extensively and intimately it affects man's well-being. But surely Dr. Slade spreads his net too widely if "inconvenience to man" is to be specified as the main feature of a pest. Many birds may on occasion be an inconvenience in our gardens, but the species that rank as pests are few, and they detrimentally affect man's well-being. A dire word should surely be retained for grave ends.

It has frequently been stressed that most of the important insecticides and fungicides have been known for many years and that chemical research has added few to their number. Dr. Slade only in part answers this challenge, and confesses that chemists are finding the replacement of certain insecticides a formidable task. Many discoveries in all branches of science and industry have been due to chance, but their systematic improvement and development have been the result of strenuous and systematic research. The discovery of derris root in 1848 by Oxley was apparently a chance one, but its introduction to the Western world by Durham was the result of scientific research, its improvement resulted from years of selection research by Georgi and his co-workers in the Department of Agriculture in Malaya, and the structure of its active principles from the labours of a number of scientific men. Here one notes a feature which adds to the chemist's difficulties—the structural asymmetry of the insecticidal principles derived from plants, and the dependence of their very potent toxic action upon minute particulars in specific structures. The need at present, at least upon the research side, is a more intimate physiological knowledge of how these potent principles act. The co-ordination of effort between chemist, physicist and biologist, which Dr. Slade rightly stressed, needs carrying, and will be carried, a further stage.

Such a consideration is true in the fungicide field as well, but with a slightly different orientation. This field of work is closer in character to that of chemotherapy, and in the case of seed dressings and in the use of certain organic colouring matters as fungicides has at least benefited by the association.

Dr. Slade dealt only very shortly with the technical procedures used in the laboratory or the field for evaluating results. But to both of these much research has been devoted, and also to the statistical methods of analysing the data accumulated and stating their significance. It thus happens that whereas twenty-five years ago only a general personal impression of a roughly qualitative kind could be given of the relative merits of various chemical control measures, to-day, a degree of certainty which is at least as great as that obtained in the majority of biological experiments can be realized.

Dr. Slade's lecture was almost strictly impersonal in its outlook and dealt severely with facts ; history, theory and generalization being eschewed. But such pioneers as H. E. Durham and J. D.

Gimlette, connected closely with the early introduction to general use of derris root, and that far-sighted planter Gilbert Walker, who first raised pyrethrum in Kenya, do deserve to be known and to be well thought of at this time. The encouragement given to researches on pest control by the Ministry of Agriculture and the Agricultural Research Council was justly emphasized, and there is abundant evidence at the present time that other official and public bodies are now fully aware of their importance for the preservation of stored produce, and for public health; there are, too, welcome signs of increasing consultation and co-operation between those who are carrying them out.

Definite advances in the use of the simpler organic chemical compounds as fumigants, contact insecticides and seed dressings have emerged in recent years; but one may feel a sense of frustration in that such compounds as hydrocyanic acid, lead arsenate, and Bordeaux mixture have not been completely replaced by equally efficient products, completely harmless to man. Yet there is satisfaction in feeling that so many organisms which are not only pests themselves, but also in many cases carry others still more pestiferous, are by the application of scientific method gradually being brought under control.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, June 5

Association for Scientific Photography (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4 p.m.—Prof. J. Yule Bogue: "Applied Photography"; Miss K. C. Clark: "Indirect Radiography as applied to Medical Work"; Dr. L. Mullins: "Miscellaneous Applications of Industrial Radiography"; Mr. C. D. Reyersbach: "Sub-Standard Kine-Photomicrography"; Mr. H. M. Ross: "The Photography of Photo-Elastic Stress Patterns".*

Monday, June 7

British Social Hygiene Council (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 3.30 p.m.—Extraordinary General Meeting. Reports of Enquiries on (1) "The Emotional Factor in Production"; (2) "The Persistently Promiscuous and the Prostitute"; (3) "Politics and Social Biology".

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8 p.m.—Mr. Patrick FitzGerald: "Northern Marches of Yunnan".

Tuesday, June 8

Town and Country Planning Association (at the Connaught Rooms, Gt. Queen Street, London, W.C.2), at 1 p.m.—Presentation of the Howard Memorial Medal to Prof. L. Patrick Abercrombie.

Quekett Microscopical Club (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 7.30 p.m.—Prof. H. G. Jackson: "The Evolution of Terrestrial Invertebrates".

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 8 p.m.—Dr. H. S. Hopf: "Biology or Rassenlehre ?—Considerations on a Vital Subject in the Curriculum".

Wednesday, June 9

Institution of Gas Engineers (at 1 Grosvenor Place, London, S.W.1), at 10 a.m.—80th Annual General Meeting; at 10.15 a.m.—Presidential Address by Mr. E. V. Evans.

Thursday, June 10

Town and Country Planning Association (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Mr. Raymond Evershed: "The Uthwatt Report".

Friday, June 11

Association of Applied Biologists (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11.15 a.m.—Discussion on "Composts: their Preparation and Value".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. Bryan H. C. Matthews: "Human Limits in Flight".

APPOINTMENTS VACANT

Applications are invited for the following appointments on before the dates mentioned:

Graduate or equivalent in Electrical Engineering, Graduate in Mathematics and Physics, and a well-qualifi Teacher of Engineering Workshop Practice and Engineeri Drawing, at the Bridgend Mining and Technical Institute—T Director of Education, County Hall, Cardiff (June 11).

Headmaster of the Junior Technical School of Acton Tec nical College—The Secretary (T), Middlesex Education Committ 10 Great George Street, Westminster, London, S.W.1 (June 14).

Demonstrator (man or woman) in the Physics Departme in London—The Warden and Secretary, London (Royal Free Hospit School of Medicine for Women, Reed Hall, Streatham Drive, Exe (June 15).

Senior Lecturer in Chemistry, and a Senior Lecturer Physics—The Clerk to the Governors, South-East Essex Techni College and School of Art, Longbridge Road, Dagenham, Ess (June 16).

Lecturer in the Department of Mechanical Engineering The Principal, Huddersfield Technical College, Huddersfield (June 1

Lecturer in Veterinary Pathology—The Registrar, The U versity, Liverpool (June 18).

Psychiatric Social Worker (female), non-resident, to co-opera with medical staff in investigating history and social welfare of men cases—The Medical Superintendent, Durham County Mental Hospit Winterton, Sedgefield, Stockton-on-Tees (endorsed 'Social Worke (June 19).

Director of the Transvaal Museum, Pretoria—The Secreta Office of the High Commissioner for the Union of South Africa, Sou Africa House, Trafalgar Square, London, W.C.2 (June 26).

Lecturer in Animal Husbandry at the Imperial College Tropical Agriculture in Trinidad—The Acting Secretary, Imperi College of Tropical Agriculture, Grand Buildings, Trafalgar Squa London, W.C.2 (June 30).

Assistant Engineers (4) in the Department of Posts a Telegraphs—The Secretary, Civil Service Commission, 45 Upp O'Connell Street, Dublin (July 2).

Lecturer in the Engineering Department—The Registra *Technical College, Cheltenham.*

Junior Instrument Maker in the Surgical Instrument Pr duction Department, Government of India—The Secretary, Ove seas Manpower Committee (Ref. 756), Ministry of Labour and Nation Service, Sardinia Street, Kingsway, London, W.C.2.

Refractories Engineer (with General Engineering training a particularly experience in Refractory Work, such as Retort Settin Coke Oven Erection and Maintenance, including the Building of Ki *Linings, Chemical Brickwork and Furnace Work*)—The Ministry Labour and National Service, Central (Technical and Scientifi Register (Ref. C.1647X), Alexandra House, Kingsway, Londo W.C.2.

Lecturer in Physics—The Clerk to the Governors, South-We Essex Technical College and School of Art, Forest Road, Walthamsto London, E.17.

Master for Chemistry—The Principal, County Secondary Scho and Cumberland Technical College, Workington.

Junior Scientific Assistant (temporary) in the Departme of Economics—The Advisory Economist, Harper Adams Agricultu College, Newport, Shropshire.

Psychiatric Social Worker—The Medical Superintende Springfield Mental Hospital, Tooting, London, S.W.17.

Second Psychiatric Social Worker—The Medical Superi tendent, Three Counties Mental Hospital, Arlesey, Beds.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Fortieth Annual Report, 1942–1943, of the Imperial Cancer Resear Fund. Pp. 32. (London: Imperial Cancer Research Fund.). [1

Reports of the Council and Auditors of the Zoological Society London for the Year 1942. Pp. 17. (London: Zoological Society London.) [1

A Plan for Education. Pp. 16. (Cheltenham: National Union Teachers, Toddington.) 1*d*. [1

Institute of Welding: Welding Research Council. Memorandu on Deep Penetration Butt Welding and Semi-Automatic Welde (T. 10.) Pp. 4. (London: Institute of Welding.) [2

Other Countries

Brooklyn Botanic Garden Record. Vol. 32, No. 1: The He Garden of the Brooklyn Botanic Garden. Part 1: Culinary Her their Culture, Traditions and Use, by Elizabeth Remsen Van Brun Part 2: Cooking with Herbs, by Virginia Riddle Svenson. (Gui No. 15.) Pp. 42. (Brooklyn, N.Y.: Brooklyn Institute of Arts a Sciences.) [1

Annals of the Carnegie Museum. Vol. 29, Art. 14: New and Ra Ithomiinæ (Lepidoptera) in the Carnegie Museum. By Richard M. Fo Pp. 397–408+1 plate. (Pittsburgh, Pa.: Carnegie Museum.) [1

U.S. Department of Agriculture. Circular No. 663: A Method Estimating Reduction in Yield of Wheat caused by Hessian Fly Inf tation. By C. C. Hill, E. J. Udine and J. S. Pinckney. Pp. 10. (Was ington, D.C.: Government Printing Office.) 5 cents. [2

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PHYSICS Dept.

NATURE

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HOURS OF WORK, HEALTH AND EFFICIENCY

HOW many more wars will be necessary before those responsible for working hours learn that man is not a machine, and that the very qualities that enable him to rise above himself for an emergency period prevent him from continuing that process indefinitely? This question is prompted by a consideration of "Hours of Work and their Influence on Health and Efficiency", by Dr. H. M. Vernon, recently published by the British Association for Labour Legislation*.

In war-time, the question of hours of work becomes of immediate importance owing to the need for maximum production. It is therefore obvious that as many hours must be worked as will make this possible over a prolonged period. This aspect is easily understood, but it should be equally obvious that the health of those doing the work should not be injured by demands that are neither physiologically nor psychologically reasonable. If these demands are enforced, production suffers in two ways; first, by the lowered production of those present; and secondly, by the absenteeism of those who break down.

In peace-time, the hours of work for different categories of workers and age-groups are carefully regulated, but in war-time a general relaxation of the regulations is inevitable. The serious situation caused by the evacuation of the British Expeditionary Force from Dunkirk led to an immediate extension of working hours; the seven-day week and the twelve-hour day applied to thousands of workers, women as well as men, and the almost superhuman efforts made by the munition workers did result at first in an enormously increased production, which however gradually fell, owing to the cumulative effect of fatigue, to the pre-Dunkirk level. This effect of fatigue was known during the War of 1914–18 and the data were published in the Report of the Health of Munition Workers' Committee. It is unfortunate that many factory managers and people in responsible positions are so much impressed by the increase of output resulting immediately from an increase of working hours that they are apt to continue the overtime indefinitely. It is seldom that they ascertain by careful measurement what exactly is happening to production.

Another condition often overlooked is that the proportion of women to able-bodied men increases from week to week during war. Women have usually, in addition to the hours in the factory, home duties which are often heavy enough in peace-time but still heavier under war-time conditions. The result has been a serious reduction in the hours devoted to sleep. It is true that the Minister of Labour recommended in July 1940 that there should be a return to more reasonable hours of work, but the gap between the recommendation and its application still remains in too many factories.

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* Hours of Work and their Influence on Health and Efficiency. By Dr. H. M. Vernon. Pp. 38. (London: British Association for Labour Legislation, 27 Clareville Grove, S.W.7, 1943.) 9*d.*

Apart from reduced output, long hours result in an increase of absenteeism, of which sickness represents approximately half the total loss, although the relationship varies from factory to factory. Some of the casual absence is due to the demands of shopping, to the illness of children or to sheer fatigue. The sickness rate of men almost doubled itself after the 70-hour week was imposed; but the 65-hour week was accompanied by quick recovery. The 60-hour week in the case of women led to a considerable increase of illnesses diagnosed as nervous breakdown. Not only adults but also far too many young persons have been working dangerously long hours, with the result that many are physically and mentally exhausted. Such hours were illegal, but that does not lessen the effect on the health of the young people. The Select Committee on National Expenditure has emphasized the importance of abolishing Sunday labour : in one factory the workers lost more than three times as much time when the hours were raised from 56 a week to 69½ by means of a longer working day and work on Sunday.

In 1940 the accident-rate of fatal, non-fatal and minor accidents rose considerably above the pre-war level. The employment of inexperienced and young people is partly responsible, but it is also known that the frequency of accidents is influenced by long working hours.

If the worker finds conditions too onerous, he may absent himself altogether. The result is a high labour turnover. To restrict this tendency, in April 1941 the Government introduced the Essential Work Order, according to which no person could leave his employment or be discharged (except for serious misconduct) without the permission of the National Service officer. This had the immediate effect of reducing the labour wastage, but nevertheless in some factories workers have found ways of evading the order.

It is recommended that in the interests of production as well as of health, the ordinary regulations of the Factories Act should be kept except for special temporary conditions. For men a working week in excess of 60 hours usually leads to no increase in production, and for women the hours should never exceed 54. Young women aged sixteen and seventeen should not work more than a 48-hour week, though youths of the same age can do up to 54 hours. Boys and girls aged fourteen and fifteen should be limited to 44 hours.

The importance of limitation of hours of labour has been recognized by the Government for some time, and one result has been an investigation of the effects of war-time hours of labour on young persons. In December 1941 the Government decided that youths and girls aged sixteen and seventeen were to register, so that the local education authorities could make contact with them and that they might be encouraged to fit themselves for national work. Most of the interviewing panels were much impressed by evidence of the strain upon young people due to long hours of work. The actual working hours were rarely excessive, but to the official hours must be added the hours spent in travelling. Also many of the young people were doing two or more jobs ; for examp colliery boys doing farm work in the evenings, gi doing normal factory hours and, in addition, worki in fish-and-chip shops or acting as usherettes cinemas in the evening. In the case of young gi who were running the home while their parents w at work, the interviewers felt that they were oft carrying a burden too heavy for their years, leavi very little time for recreation. The interviewers w most impressed by the calibre of the young peo and of their general morale, but point out the la of attention they have received since leaving scho The most alarming symptom was that of men lassitude in those who were unable to get adequa time for relaxation and recreative activity.

The report of the investigation, which has be issued as a White Paper by the president of t Board of Education and the Secretary of State f Scotland (Cmd. 6446*) outlines the action which is proposed to take. Hours of employment are to reviewed, travelling times reduced by transferri youths where necessary to employment nearer th homes, feeding arrangements are to be examin and interviewing panels are to discourage und activities outside working hours. These steps a all in the right direction, but speed is necessary prevent undue strain on those who, while they a contributing to the war effort, are also the foundati on which will fall a heavy burden in the early yea of peace.

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* Board of Education: Scottish Education Department. Yo Registration in 1942. (Cmd. 6446.) Pp. 28. (London: H.M. Statione Office, 1943.). 6*d*. net.

FARM AND FOREST IN COLONIA ADMINISTRATION

ALMOST alone among the former great Powe the Anglo-Saxon race has ignored the intima relation existing between agriculture and forestr This is as true of the United States of America as is of the great Dominions of the British Empire an the Colonies under the administration of that Empir The Anglo-Saxon races all had the same cradle, th island of Britain, and they all seem to lack feelin for the relation of agriculture to the forest. I connexion with future planning of the British countr side, reports have been issued in which the forestr side of this question is either totally ignored or r ceives scant mention. This want of appreciation i the past of the true rôle of the forest may have bee a natural outcome of the absence for so long of sub stantial forests in Britain ; the large areas of sem derelict land in the mountainous and more out-o the-way tracts being practically unknown or, at leas disregarded.

The Anglo-Saxon races have carried with the this lack of appreciation of the value of the fores to agriculture all over the world ; in the New Worl the United States and Canada, eastwards to Australi and New Zealand, and many Colonies. But ou side Great Britain, the position was very different. Enormous stretches of forest, apparently inexhaustible, were in existence. Since the new-comers had no idea of the value of the forest or its relation to other conditions of the countryside—to mention one, water—a relentless war was waged on these great forests. This war varied. It might be pure lumbering to supply ever-growing markets—wasteful lumbering often accompanied or followed by great fires which swept away large tracts of natural forest as yet unexploited. This type was commonest in the New World. In the more tropical forests in the Old World containing a large number of species of trees, only a few of which had any marketable value, the removal of the salable individuals, while reducing the commercial potentiality, still left a forest on the area. The damage here was due to other but equally destructive practices.

The general results of the maltreatment of the forest in various parts of the world by the Anglo-Saxon race (or through their instrumentality) during the past century, to go no farther back, are well known, although the results of such treatment are still disputed by administrators and by considerable sections of the public, few of whom in the past were given that modicum of scientific training which would have enabled them to appreciate some of the more elementary laws of Nature. The British Empire was not the only offender. The citizens of the United States have shown equal misunderstanding of Nature and her decrees. Indiscriminate lumbering of the forests and over-utilization of the great corn lands have led to disasters both in the United States and Canada. Excessive sheep farming has occurred in Australia, and uncontrolled firing of the countryside in New Zealand. Soil sterility and erosion have put out of commission thousands of farms.

The reasons and causes of this treatment of the forest and soil may be different, but the aftermath in no way differs from the growing impoverishment, and in cases sterility, of the soils of many British Colonies. The administration of these latter, in that it has put an end to internecine strife between the tribes or chiefs, introduced education, health measures, sanitation and so forth, is as good as can be found anywhere else in the world—in methods often far superior. The British administrations have, however, been guilty of an error of judgment in the rigid application of the early introduced rule that all interference on the part of the administration with the local practices, habits and customs of the people was deprecated and would not be countenanced. Consequently such common practices as shifting cultivation, firing of the countryside in the hot season and unrestricted grazing by herds of stock, increasing with amazing rapidity under the *Pax Britannica*—all these practices continued unchecked in the form found when the country was taken over. The inevitable results, as in the case of the New World and in the Dominions of the British Empire, were not foreseen or the dangers even appreciated.

In New Zealand, at least, a recognition of one of the causes of erosion, namely, unchecked firing of the countryside, has begun to make its appearance. In the Dominion Forestry Report (March 1942) on the subject of soil erosion one reads:

> "Forest clearing and grassing have ceased on all State-owned lands, and attempts to grow one blade of grass where two trees grew before are now recognized as the root cause of the Dominion's erosion problem. Should further forest clearing be allowed on any lands—private or Native—if it contributes to accelerated erosion? In the belief that the public is convinced of the necessity for controlled clearing of all forested land, irrespective of ownership, appropriate recommendations are being drafted for consideration by the Government."

In how many of the Colonies of the British Empire could such a statement be made? A great deal has been heard recently of the attempts to improve agricultural methods there. In the past, every effort was made to improve the commercial and financial position—the so-called development of the Colony—by the introduction and growth of crops of tea, coffee, cocoa, sugar, rubber and so forth, all at the expense of the forest, for the development was made by the large-scale felling of the most valuable, because the richest in commercial timber species, of the forest areas. For a time, all went well. Wealth came to the Colony and the planters, while the natives continued their old practices of shifting cultivation, etc., in the rest of the accessible forests. But the rich forest soil, the product of centuries of conservation under the canopy of the trees, gradually became used up and dissipated when exposed, for little protection was afforded to it by the crops grown. We are now facing the results to be expected, and the British taxpayer will be called upon to foot the bill.

The administrations still appear to regard it as a purely agricultural matter. More research, it is said, will lead to a better because more intensive agriculture. Is this a logical conclusion because, in isolated instances, a Colonial agricultural department can show, on a small scale, the example of a success? In Africa it is beyond question that the soil of the Continent is becoming increasingly impoverished by the very means by which great tracts of that old Continent have become reduced to desert, or practically desert conditions, by man in the past.

It was in justification of this belief that the Royal African Society set up a small Commission of Research for Africa and invited representatives who had been administrators in those Colonies from the Free French, Belgian and Dutch Governments in London to serve on it. The two British representatives were both retired officials, one a former lieutenant-governor. The Commission came to unanimous conclusions on the subject of shifting cultivation, bush fires, grazing, reservation of forests, and erosion, and suggested practical proposals for dealing with those evils—evils which the administration has refrained from touching for so long, as an interference with the habits and customs of the people. It may be hoped that the Secretary of State for the Colonies may yet find time to study this important problem, vital to the future well-being of the large populations under his care.

MODERN BIOMETRY

Statistical Analysis in Biology

By Dr. K. Mather. Pp. iv+248. (London: Methuen and Co., Ltd., 1943.) 16*s*. net.

DR. MATHER'S book begins with the remarkable statement that "Statistics is the mathematics of experiment". In fact, statistics originated in the spheres of demography and economics, where experiment is difficult, dangerous, and rarely scientific; and among their most successful spheres of application is astronomy, where it is wholly impossible. Perhaps it is for this reason that Dr. Mather completely ignores the construction and interpretation of life-tables, though these are not merely fundamental for human biology, but are assuming an ever-growing importance in animal biology also. Nor is there any suggestion for the treatment of statistics of fertility, such as are given in Salisbury's "The Reproductive Capacity of Plants". Yet any theory of evolution must be based on such data as these.

In his mathematical analysis, "The primary concept of statistics," Dr. Mather tells us, "is that of the infinitely large hypothetical population of which the observed data form a sample". Certainly theoretical statistics can be built up around this concept. But they can also be built up around that of a random variable, or around that of probability in accordance with such axioms as those of Jeffreys. Many writers regard one or both of the latter approaches as logically sounder, if only because they do not necessitate the concept of likelihood, which is not derivable from that of an infinite population.

The ground covered by Dr. Mather is much the same as that covered by Prof. R. A. Fisher in "Statistical Methods for Biologists" and "The Design of Experiments", and his debt to Fisher is obvious and fully acknowledged. As compared with these books, Dr. Mather's gives a fuller account of some arithmetical methods. His discussion of the inter-relations of the normal deviate, χ^2, Student's distribution, and that of the variance ratio, is illuminating, as is his detailed account of the individuality of degrees of freedom.

But, as might perhaps be expected from his opening paragraphs, Dr. Mather's treatment is sometimes logically incorrect. Thus, after finding χ^2 for a 2×2 contingency table on p. 193 to be $1 \cdot 17$, he adds that this shows "that there is no interaction between the classifications, i.e., that the type of water does not affect germination". Actually it proves nothing of the kind. It merely shows that if loam water leads to better germination of seeds than rain water, or conversely, a test on a hundred seeds is inadequate to demonstrate the fact. But it is entirely possible that a test on several thousand seeds would have shown 15 per cent more germination with loam water than rain water. Perhaps if the author were accustomed to thinking in terms of probability rather than of infinite populations, he would not have fallen into this elementary fallacy. It is sometimes as important to realize what statistics do not prove as what they do prove.

On the whole, Fisher's approach in the books mentioned is not only more logical than Dr. Mather's, but is also likely to be more intelligible to a beginner. Nevertheless, Mather has cleared up a good many points which Fisher treated rather rapidly, if at all.

The ideal book on statistical methods for biologists has not yet been written, and perhaps never will be. But it is worth speculating on its contents. It would include the mathematical proof of the validity of all methods used. It is perfectly true that the majority of biological students are willing to take statistical methods for granted, as they take microscopes. But those who possess the scientific spirit in any large measure will certainly insist on understanding chromatic aberration, on one hand, and skew frequency distributions, on the other. Actually the necessary mathematics could be compressed into a smaller space than might be thought.

Secondly, it would deal with the history of biometry, which has some bearing on its present situation. Forty years ago, a spectator of the controversy between Bateson and Pearson might well have said, "I don't know which is right, but it is certain that both of them can't be". As a matter of fact, both of them were so to a very large extent. To-day the views of certain statisticians appear to be quite irreconcilable. Yet a historical retrospect suggests that all may be of value. Thus Neymann and Pearson, Fisher, and Jeffreys, use different criteria of significance, each defending his own point of view with considerable force. They have been mainly concerned with industrial products, living organisms, and earthquakes respectively, and each may have chosen the best method in his own field; but these methods may be of some value outside that field.

Thirdly, it would deal with all the important applications of statistics to biology. A very brief survey would show how unevenly statistics have been applied. Thus, for obvious economic reasons, the preparation of life-tables now rests on a very complex and meticulous technique, while that of growth curves is in an embryonic condition.

The book before us fulfils none of these conditions, nor of course does it claim to. The formulæ of the main theoretical distributions are given, none the more intelligibly for containing factorials of fractions, the meaning of which is nowhere explained; and the statement on p. 35 that "moments of order higher than the second are not often used", if true, merely suggests that biometry is in a somewhat decadent condition. The assumption that any distribution may be treated as normal has led to serious errors in recent years, notably in the comparison of mutation-rates and the detection of linkage.

Dr. Mather is nothing if not up to date. "The correlation coefficient," he tells us, "has occupied a very important place in statistics, but its use is gradually dying, as the method of regression will always offer as good a solution to a problem, and frequently better." No doubt in individual cases regression coefficients tell us a little more than correlation coefficients. But they do not enable us to compare the relations of different variates; for example, to answer the question whether we can predict brain-weight better from body-weight or head circumference. Also they are essential in the study of heredity, not only according to the methods of Pearson, but also to those of Sewall Wright, which are fully applicable to Mendelian cases. The broader the generalization reached, the more does correlation prove superior to regression.

These opinions can be explained by the limited field from which Dr. Mather's examples are drawn. Grossly skew variation is found, for example, in the distribution of weights, of drug tolerance, of life expectations, and of fertilities, but these are not considered.

When all these criticisms have been made, the book will be of value to a great number of biologists. The tables at the end are very succinct, and sufficient for many purposes. The treatment is often more detailed than in any other similar book. There is at least a fair probability that a research worker will find here, and nowhere else, a detailed description of a method suited to his or her particular problem. But just because "Statistical Analysis in Biology" will fill a gap, it is essential to point out its very real limitations.

J. B. S. HALDANE.

HIGH FREQUENCY THERMIONIC TUBES

High Frequency Thermionic Tubes
By Dr. A. F. Harvey. Pp. viii+235. (London: Chapman and Hall, Ltd., 1943.) 18*s.* net.

DURING the past quarter of a century the technique of the application of electric waves to communication and other problems has been steadily progressing to shorter and shorter wave-lengths. Naturally, research on more fundamental problems was in advance of these applications, but it is likely that time will disclose in due course how much this gap has been shortened during the past few years and to what extent the previous trend has been accelerated under the stimulus and incentive of war-time conditions. The crux of the problem in all this work is the development and adaptation of the thermionic valve in one of its many forms to the generation of the very high frequency oscillations required at the correspondingly short wave-lengths.

In Dr. Harvey's book we have a very thorough survey of the published literature on the special types of thermionic tubes which have been developed for the above purpose; and this survey is supplemented by a more detailed account of the author's own work on the performance and operation of the magnetron in one of its several modes of oscillation.

The book opens with an introductory chapter on the general properties of valves, which might, with advantage, have been omitted or abbreviated. The author then proceeds to a description of the effects of electron inertia in limiting the performance of the normal type of thermionic valve, and of certain commercial types of valves designed to minimize these effects. Later portions of this chapter deal with measurements of valve characteristics and parameters at very high frequencies. Chapter 3 deals with the retarding field type of generator, in which the electron inertia effect in valves is utilized to advantage for the production of very high frequency, although somewhat weak, oscillations. An account is given of various experiments made with positive ions in the valves with the object of increasing the transit time and so enabling the oscillations to be studied at a frequency of the order of one five-hundredth that obtained with electronic oscillations in ordinary valves.

The next two chapters, occupying nearly one half of the whole book, deal with the characteristics and properties of the magnetron valve, and with the results obtained when it is used to generate oscillations in one of the several possible forms. Much of the material in this portion of the book is derived from the author's original work, although adequate reference is made to the results of other investigators. In one form of oscillation generator, the negative-resistance property of the magnetron is utilized to produce 'dynatron' oscillations at a frequency determined by that of the external circuit attached to the valve. Two other types of oscillation, termed resonance and electronic respectively, are possible with a magnetron; and each of these shows the characteristic that, whenever the frequency is changed, both the operating conditions of the valve and the component valves of the external circuit have to be changed. This is one of the factors that largely limits the applications of the magnetron to single-frequency operation. The characteristics of these resonance and electronic oscillations are described at length, and it is pointed out that they are fundamentally the same. In this work, the author has clarified some of the confusion that has arisen from time to time between these and the dynatron type of oscillation referred to earlier. This portion of the book is, in many ways, the most important, because short wave oscillations in magnetrons are usually of the resonance type.

The sixth and last chapter of the book is devoted to a brief description of the klystron type of oscillation generator, in which velocity modulation of the electron stream is used with associated electromagnetic resonators. The later portion of this chapter deals very briefly with wave guides and horn radiators for use at very short wave-lengths.

To each chapter of the book is appended a very comprehensive bibliography of references to the literature on the subject; these are mostly confined to publications up to about 1939, although some later references have been included. The extensive nature of the literature on this subject prior to the outbreak of war is indicated by the fact that more than five hundred references are contained in the book, which will clearly fulfil a most useful function as a first comprehensive survey of this field of thermionic valve technique.

FISHERIES OF LAKE NYASA

Report on the Fish and Fisheries of Lake Nyasa
By C. K. Ricardo Bertram, H. J. H. Borley and Ethelwynn Trewavas. (Published on behalf of the Government of Nyasaland.) Pp. 181+12 plates. (London: The Crown Agents for the Colonies, 1942.) 12*s.* 6*d.*

MRS. RICARDO BERTRAM is a naturalist (fisheries), Miss Trewavas is a systematist (ichthyology), and Mr. John Borley is an administrator with a background of natural history, and between them they studied the fisheries in Lake Nyasa, and, in spite of many difficulties, they have followed up their eight months in the field by producing this handsome report. The report is well set out, clearly written, and illustrated with beautiful and instructive photographs. With its generous appendixes, it will be the standard work on the subject for many years to come. It has no index.

The study of an African lake makes a wide subject. This report, very properly, deals with geography, anthropology, nutrition and economics. Lake Nyasa is 350 miles long and not more than 50 miles wide anywhere; it has a deep area, 300–400 fathoms, but the ends are shallower, especially the southern. The water is rather alkaline, clear in the middle of the Lake, devoid of oxygen in the depths. The level of the Lake varies considerably. There are many kinds of fish. Counting the many species of certain fruitful genera as one, there are about thirty important kinds of fish in the Lake, mostly cichlids, cyprinids and silurids, with a few mormyrids and others, but, curiously, no lung-fishes. In all, 223 species are recognized so far: about 250 native names are listed, many, of course, being duplicates.

As in the Victoria Nyanza, two nearly related species of Tilapia provide most of the catch of edible fish. This is a case of parallel evolution, of which the Cichlidæ endemic to various African lakes provide several examples. The differences both in habit and in anatomical structure between the two Tilapias of Lake Nyasa are closely similar to the differences between the two species in Lake Victoria.

Fishing by Europeans has only recently been introduced to Lake Nyasa. The methods include seine nets, which were already established in the native fisheries, along with gill-nets, baskets and lines. The Fisheries Survey carried out experimental fisheries, as well as fish-marking, but the work did not pass the experimental stage. The Survey also tried to improve on the crude methods of curing employed by the natives, but this, too, requires further experiment.

Indeed the outstanding feature of surveys of the fisheries of African lakes, of which the Lake Nyasa survey is the sixth—no less—is the need for following up (see also Worthington, E. B., NATURE, **151**, 353; 1943). The surveys have all shown that the fish trade needs development for the sake of the diet of the natives, but so long as there is no determined policy, and neither a plan nor people to implement the investigators' conclusions, nothing much can follow. The present report shows the scale of the economic and administrative problems involved, and they are worth mentioning here.

First, as matters are at present, the level of Lake Nyasa is always changing. In 1931 the mean annual level was 5 ft. above that of 1902. Consequently rice fields that were productive in 1902 are useless in 1931; sand-spits that gave shelter to parts of the shoreline are submerged; and beaches are studded with stumps of trees, so that a seine net cannot be worked. Rivers running into the lake have become sluggish and clog with vegetation, making them unsuitable for the sandy nests of the valuable Tilapia. What is wanted is stabilization of the level of the Lake, which would also reduce erosion by rivers changing their courses, and allow of afforestation in the Lake area. Stabilization would certainly allow further development of the fisheries, because beaches could be cleared for seining with some prospect of the site remaining useful.

The fisheries also need further action to encourage trade. The Nutrition Survey—with which the Fisheries Survey was associated—showed that many of the natives of Nyasaland depend on fish for proteins, minerals and certain vitamins. "With rare exceptions, however, fresh fish is not available to natives living more than about three miles away from the lake shore, though a crudely cured product is eagerly bought whenever possible by people living away from the lake", whose main diet consists of a single cereal, such as maize or kassava. But you cannot get the fish to the hill people unless the hill people have some trade article that the lake people need, such as a surplus of flour. Clearly, there are technical problems to solve, such as transport and preservation of the fish; but there are also social habits to consider, and the building up of a regular and voluminous trade can only be done by directed fostering over a considerable period. Among the many details that need attention, a supply of salt bulks large: at present it is rare and precious everywhere in central Africa.

Now that no country in the world knows how much or how little it is going to direct trade and production, it may be easier, psychologically, to direct matters like native trade, when the health of the natives demands it. Naturally, in considering the fishery of Lake Nyasa, it is of importance first to have these investigators' informed opinion that the stock of fish would stand up to carefully controlled expansion of the fishery. (Unfortunately, I disagree with their definition of over-fishing; but they refer to papers of mine, which brings the blame to my door, for not making the theory more clear.) Whether the administration will be able to follow up these investigators' work or not, this report shows that the Survey, without which there could be no following up, was well accomplished.

MICHAEL GRAHAM.

A SWEDISH VIEW OF BRITAIN

Sweden Speaks
Edited by Gustaf Witting. Translated by Edith M. Nielsen. Pp. 212. (London: George Allen and Unwin, Ltd., 1942.) 8*s*. 6*d*. net.

THIS book on the British contribution to civilization, written by a group of distinguished Swedes in 1940, when the outlook for Britain and the whole movement of humanist development since the Renaissance was exceedingly dark, will strike many British readers as superior to most of the British works of the same sort. The Swedish writers are noticeably better informed than British authors on this subject. Perhaps this is because few British writers of the first rank have addressed themselves to it.

The essays in this volume include reviews of scientific research in England by Ansgar Roth, and medical research in England by Prof. Göran Liljestrand. On the first page of Dr. Roth's essay there is an account of Prof. P. A. M. Dirac's forecast of the existence of the positive electron, and a new form of hydrogen. On the second page of Prof. Liljestrand's essay we already learn of the triumphs of Sir Thomas Lewis in the investigation of the heart and the capillaries. These are examples of the admirably modern tone of the book.

The world wishes to know what Great Britain is contributing in the present and what she promises for the future. The British critical historical expositions of Newton, Darwin, and the other masters of the past are meagre, yet even so they smother the negligible corresponding studies of the masters of the present. This has had two ill-effects. The merits of the present British scientific contribution have not been rightly assessed by people overseas, nor its defects by people at home; with the result that our friends believed we were weaker than we are, and we have been too ignorant of our own condition to make the best use of our abilities.

J. G. CROWTHER.

Course of Instruction in the Qualitative hemical Analysis of Inorganic Substances

y Prof. Arthur A. Noyes. Tenth edition, revised nd rewritten by Prof. Ernest H. Swift. Pp. xv+418. New York: The Macmillan Company, 1942.) 14s. et.

THE new edition of this well-known text-book brings several important and useful features ito the text. The general plan of the work is to rovide a really practical laboratory guide to qualiative analysis in a framework of theory and general hemical knowledge which should lead to intelligent ork and to the acquisition of a grasp of fundamental rinciples which can, as the authors fully realize, be nade to result from a good course in qualitative nalysis. Many of the experiments are semi-quantiative, and throughout emphasis is laid on the posibility of working with small quantities of material, procedure which not only teaches manipulative kill but also lays the foundations of later work on uantitative analysis. Several literature references re given, and difficult points are explained clearly nd fully. A good feature is the use made of the nodern theory of strong electrolytes, and such natters as the theory of solubility product are dealt vith in a modern way. The book is arranged so that he work of the teacher will be simplified and lightned, and throughout the student is encouraged to hink for himself, a large selection of questions, ncluding numerical examples, being provided.

There is no doubt that this is one of the best textooks on qualitative analysis, and even those who re familiar with the subject and have taught it for long period should find something new and interestng in many of the sections. All teachers are recomnended to have the book even if they do not adopt t in their classes, since the discussions of many parts f the theory, and the numerous alternative methods iven in it, must prove of the greatest value. It hould be emphasized that, although the book covers he theory in an admirable way, it is thoroughly ractical, and abounds in manipulative hints which nake it a sound laboratory guide.

adio Receiver Design

y Dr. K. R. Sturley. Part 1: Radio Frequency mplification and Detection. Pp. xii+435. (London: hapman and Hall, Ltd., 1943.) 28s. net.

THE principles upon which radio receivers of various types are designed at the present time ave been developed by various technical workers, ho have in many cases specialized on particular pplications or even on integral portions of the eceiver itself. As a result there is a widespread and aried literature on the subject of receiver design, vhich has for some time needed digesting and lassification. In the book under review, Dr. Sturley as met this situation by bringing together the undamentals of receiver design for the benefit of hose engaged in this class of work. After two ntroductory chapters dealing with general consideraions and valves, the order of treatment is to follow he received signal from the aerial through the radiorequency amplifiers, the frequency changer with its ocal oscillator and then through the intermediaterequency amplifier to the second detector giving an udio-frequency output. The present volume ends t this stage, leaving audio-frequency amplifiers and ower supplies to be dealt with in Part 2.

The treatment throughout is of a practical analytical nature, with care taken to insert typical numerical values as frequently as possible. Each chapter is accompanied by a bibliography, which is intended not to be exhaustive but to be helpful in the further study of the subject. The book will be welcomed by all those engaged in radio receiver design and development, whether for experimental or commercial purposes.

Atlas of the Scale Insects of North America

By G. F. Ferris. Fourth Series: Family Diaspididæ, Subfamily Diaspidinæ, Tribes Diaspidini and Aspidiotini; Family Diaspididæ, Subfamily Phœnicococcinæ. Pp. 314. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1942.) 46s. 6d. net.

IT was pointed out in the introduction to the first series of this work that the group commonly referred to as the family Coccidæ or scale insects is elevated to the rank of a super family—the Coccoidea. The present contribution deals with the remainder of the family Diaspididæ, which is divided by the author into the two subfamilies Diaspidinæ and Phœnicococcinæ—the last group including only a small number of species. As its name implies, Mr. Ferris's work is an illustrated atlas which figures the more important diagnostic characters of the North American species together with relevant descriptive letterpress.

Owing to the great economic importance of the scale insects this work is likely to be indispensable to all future investigators on account of the clarity of its illustrations and its terse but adequate descriptions, which are invaluable qualities in a work of reference. Unfortunately, the disturbed condition of the world makes the continued publication of this atlas impossible unless financial help becomes available. The author states that he is willing to complete the treatise if the requisite monetary aid is forthcoming.

Science and Ethics

An Essay by Dr. C. H. Waddington. Together with a Discussion between the author and the Rt. Rev. E. W. Barnes, the Very Rev. W. R. Mathews, Prof. W. G. de Burgh, Prof. C. E. M. Joad, Prof. Susan Stebbing, Prof. A. D. Ritchie, Prof. H. J. Fleure, Prof. J. S. Huxley, Prof. J. B. S. Haldane, Dr. C. D. Darlington, Dr. J. Needham, Prof. H. Dingle, Dr. G. Burniston Brown, Dr. Karin Stephen, Miss Melanie Klein, Miss Miriam Rothschild, Prof. J. D. Bernal, Prof. Chauncey D. Leake. Pp. 144. (London: George Allen and Unwin, Ltd., 1942.) 7s. 6d. net.

ON September 6, 1941, NATURE printed an essay by Dr. C. H. Waddington on "Science and Ethics" (p. 270). This essay had previously been submitted to various men of science, philosophers and churchmen whose comments were published in the same number of NATURE (pp. 274–280). The discussion that had been opened in this way led to further communications between Waddington and authorities on the particular subjects to which he had referred, including psychology, anthropology, Marxism and logical positivism. The entire material has now been put together and published collectively in this book. Among the contributors are the Bishop of Birmingham, the Dean of St. Paul's, Profs. Huxley, Haldane, Dingle and Bernal with Drs. Needham, Darlington, Stephen and Joad, and Mrs. Melanie Klein. The book is a notable contribution to the contemporary philosophy of science.

FOUR YEARS OF PLANNED FEEDING IN GREAT BRITAIN

By Dr. MAGNUS PYKE
Ministry of Food

TWO fundamental difficulties beset the scientific distribution of nutrients among the population of a warring nation of forty-seven million people. Leaving aside for the moment the immense practical administrative problems involved, there is first the lack of precise scientific information on a number of nutritional matters, and secondly, when the best scientific judgment available has been adopted, there is the difficulty of finding out whether the distribution of nutrients has, in fact, been effective ; and, if it has, whether the health of the people is being maintained on a nutrient provision which is itself based on incomplete scientific data.

During the last thirty years or so, the science of nutrition has concerned itself almost exclusively with the study of substances present in the diet in minute amounts. A dozen or more vitamins have been discovered, their chemical nature investigated, their physiological significance studied, their distribution in foodstuffs surveyed and the amounts of them needed assessed. The blockade of Great Britain, which put in jeopardy the supply of food itself, at once threw back the emphasis on to the weightier constituents of food.

The fundamental principles governing calorie requirements were worked out in detail by Rubner and Atwater and their colleagues between 1850 and 1907. During the War of 1914–18 and between that and the present War, Cathcart and Orr, Moss and a few others carried on the work. They were, however, only a rearguard of the classical nutritionists : the big battalions studied vitamins and minerals. In first attempts in this War to solve the problem of what was the daily calorific requirement per head of the population, it was only possible to say that 'sedentary' men needed 2,500 calories, 'active' men 3,000 and so on. This, of course, merely changed one question to another : what was a 'sedentary', an 'active' or a 'very active' man ? Any competent student, even with information mostly forty years old, could make an estimate of the national needs, but whereas in the university a margin of a hundred calories each way is unimportant, a hundred calories a day for forty-seven million people for a year represents half a million tons of wheat.

Knowledge with regard to protein requirements is even less complete than that of calorie requirements. The figure usually accepted of 70 gm. includes an elastic safety margin. Perhaps 50 gm. would suffice, and of this perhaps 25 gm. of animal protein would be enough for adults. Fortunately, the assessment of total protein requirement is only of academic interest, since the acquisition of calories in such foods as bread from high-extraction flour, and also potatoes, brings with it an intake of protein substantially higher than the minimum requirement.

The Ministry of Food has made the best assessment that scientific knowledge could suggest of the physiological requirement of each nutrient by every class of the population. Judgment was happily reinforced by almost complete agreement with similar estimates made by the National Research Council of America and published in 1941. Simultaneously with this work, at the request of the Ministry of Food, the Medical Research Council was preparing a table of food compositions to be used as a standard for calculating the composition of the national diet.

Here then was the scientific basis upon which a logical food policy could be built. Nutrients could be translated into those foods which were available and, conversely, crops and shiploads could be assessed in calories, proteins or vitamins. This scientific attitude has in the main been successful and unquestionably must be followed in the future. Freedom from want implies the distribution of food according to physiological need.

The problem, however, is not only one of distributing nutrients systematically. In the spring of 1941, after a winter of bombardment and privation the national diet of Great Britain, although physiologically sufficient, had reached its lowest ebb, and although bread and potatoes were unrationed there was evidence to suggest that calorific needs were not being filled. Nevertheless, the foodstuff in greatest demand, for which people were prepared to queue was onions, which are of negligible nutritive value. Furthermore, it was found necessary to transfer acreage intended for vitamin C crops of greenstuff to the production of mustard for pickles. It is a matter of great difficulty and importance to judge at what stage a commodity not of itself of any value becomes of nutritive significance by rendering palatable nutritious food which otherwise would not be eaten.

The Ministry of Food took over the nation's feeding as a going concern. In order to plan improvements and to assess the results of its own actions, it was necessary to know and to be informed continuously about the state of the national nutrition. Two distinct methods are used to estimate the nutrients available per head. On one hand, the amounts of food imported, plus the amounts grown within the country, are known with some degree of precision. Allowances for waste during the various stages of distribution can be made, and thus the nutrients theoretically available per head can be calculated. The degree of reliability of the results of this method of assessment depends on the precision of the Ministry's knowledge of the amounts of food in the country at any time, which, with a commodity like potatoes, for example, can never be perfect, and upon the efficient functioning of rationing and other machinery of distribution.

The second means of gauging continuously the national nutrition is the method of the domestic budgetary survey of the type which has become well known through the work of Sir John Orr. Each week of the year, about 5,000 people from twenty towns throughout the country are under investigation. This war-time food survey is probably the most important single scientific work carried out by the Ministry of Food.

Neither method of investigating the national nutrition is, of course, complete. The figures for total supplies give an estimate of the food available per head of the nation. The budgetary assessment provides a measure of the food bought per head of the family. In neither case can we reach the individual. Both methods, however, are of cardinal value. Figures based on total supply estimates are available over a number of years and render it possible for comparison to be drawn between pre-war and war years, and for estimates to be made for contingencies after the War. The figures from the budgetary surveys show broadly the effectiveness of food distribution and any nutritional changes from month to month. In the surveys, however, a child is merely a vulgar fraction of a man and we put together without distinction the heads of the coal-miner, the adolescent and the sedentary legislator.

A child's requirements for protein and calcium are proportionally higher than those of an adult. Its digestive machinery is less rugged and smaller and, since his body is growing, errors of diet in childhood may leave permanent effects. The child, then, has first call on milk. It is given supplies of vitamin D in cod-liver oil and vitamin C in concentrated fruit juice. This simple application of nutritional knowledge has not been carried out without administrative and technical difficulty. A reduction of income tax is accepted as some recompense for the expense of a child, but the provision of low-priced or free milk and orange juice to meet the special needs of the child was a new step in enlightened public administration. To provide fruit juice as a source of vitamin C it was necessary to enlist the help of analysts to insure that the stated concentration of vitamin was present in the preparation issued. This called for a certain change in outlook. The agricultural chemist is accustomed to analyse feed for its nutritive value. The analyst of human food, however, is usually engaged in a search for adulterants or preservatives.

Although the nutritive policy of the Ministry of Food is based on the distribution of equal shares to every individual, there is, in addition to the special individual provision of extra rations to children and expectant or nursing mothers and to certain invalids and other special categories, a group distribution to special classes. These classes are school children and industrial workers.

Hitherto it has been possible to obtain sufficient food to provide a nutritionally adequate diet for the population of Great Britain. First-class protein, fats and some other foods are rationed. By good fortune perhaps rather than by good management, of all nations in Europe only in Great Britain has it not yet been necessary to ration bread and potatoes. Nor are ration coupons demanded for communal meals. If bread, potatoes and communal meals were rationed in such a way as to make a material saving in food, it would probably be necessary to impose some measure of underfeeding.

To-day almost a quarter of the school-children in Great Britain receive their main meal of the day 'off the ration', and so do about an equal proportion of the industrial workers. The study of the nutritive value of these meals is an interesting matter. It has been investigated in a way similar in principle to the twofold scrutiny of the total national diet. First, the nutritive values of the catering allowances have been examined. An ordinary restaurant is allowed rations based on one pennyworth of meat per main meal. Industrial canteens receive a penny-halfpennyworth of meat and other additions. Canteens serving certain specified heavy industries are allowed two pennyworth of meat. School meals get the biggest allowances of all and two pennyworth of meat. The meat provided for the children is based on their high physiological needs of animal protein.

Rationed foods supply only a part of the total meal. Its full composition is based on custom, catering facilities and scientific advice. Those responsible for communal catering are eager for nutritional advice which is difficult to give. Daily requirements of nutrients are known with some degree of precision, but little well-grounded information is available about the desirable value for a single meal. In order to find out the nutritional value of meals known to be satisfactory; to be able to suggest improvements; and to investigate the effects on food values of large-scale catering, the Ministry of Food enlisted the voluntary co-operation of biochemists in more than a dozen towns. These public-spirited workers have analysed the meals and investigated nutritional problems which arise in providing them. This work is continuing.

A number of important technical advances have been made in fulfilling the Ministry's policy of providing a diet which people will eat and which will supply their physiological requirements. Of foremost importance is the national loaf. Eighty-five per cent of the wheat grain is used. The part which is discarded is the least digestible fraction. The discovery that a minute morphological structure, the scutellum, which divides the germ from the endosperm, is by far the richest in vitamin B_1 of all parts of the grain, has enabled a flour to be prepared which is high in vitamin content and low in fibre. A chronic deficiency of vitamin B_1 in the national diet widespread in peace-time has thus been overcome. Other important advances have been the successful production of dried milk and dried egg. Dried meat, fish and vegetables are available for the Forces. The concentrated fruit juices as sources of vitamin C and perhaps other vitamins have already been mentioned.

The application of scientific planning to the nation's food calls for a better understanding by the public of the elementary principles of nutrition. The Ministry has in the past three years conducted an educational campaign stressing such points as the proper choice of foods for a balanced diet and the careful cooking of vegetables to preserve their vitamin C. How far the effects of this campaign are permanent cannot be judged until the relaxation of war-time restrictions once again gives the housewife some freedom of choice. The success of the predominantly scientific policy of the Ministry of Food can only be measured by the economies in shipping which it has rendered possible, and, most important of all, by the health of the nation. The national health has, so far, been well maintained. Clinical surveys for the assessment of nutritional well-being, which are carried out by the Ministry of Health and others, confirm what is suggested by the Ministry of Food's own surveys of food intake, that the rational distribution of the nation's food resources has caused, in general, an improvement rather than a deterioration in nutrition in Great Britain during these four years of war.

BIOGEOCHEMICAL RESEARCH IN THE U.S.S.R.

By A. P. VINOGRADOV

GEOLOGISTS have always taken an interest in the problem of the influence of life on the chemical processes going on within the earth's crust. In the early days of the Revolution, V. Vernadsky, first in the Ukrainian Academy of Sciences at Kiev and later in the Academy of Sciences of the U.S.S.R. in Leningrad, organized, on a very modest scale, experimental work in the study of the chemical composition of organisms. His friend and pupil, Prof. Y. Samoilov, of the University of Moscow, working independently, conducted research on the part played by organisms in the formation of soils. F. W. Clarke in his "Data of Geo-chemistry"

(5th ed. 1924), the appearance of which opened up a new era, treats the same subjects mainly on the basis of American work.

It was, however, only after university courses delivered by Vernadsky in Prague, Paris and Leningrad, and the appearance of the fourth edition of his "Outline of Geochemistry" in 1930, that wide acceptance was given the postulate that the distribution, combination and migration of chemical elements in the earth's crust and in the biosphere could not be understood without taking into consideration the influence of the sum total of all organisms.

Twenty years ago, when geochemical ideas were being crystallized and the young science was being formed, together with the laws of the distribution and combination of chemical elements, the migration of chemical elements, their dissemination and concentration, and the theory of the energy-levels of crystallized natural bodies, the lack of knowledge of the chemical composition of organisms and also of soils and organogenic rocks was very keenly felt.

In 1929 V. I. Vernadsky founded the Biogeochemical Laboratory of the Academy of Sciences of the U.S.S.R. to study the laws of the distribution and migration of chemical elements in the biosphere, employing for the solution of these problems the whole arsenal of modern perfected analytical methods—spectroscopy, X-ray spectroscopy, mass spectroscopy and other chemical and physico-chemical methods. Similar research was begun later in the Chemico-Radiological Institute in Odessa, where the work was directed by Prof. E. Burkser, in the Geological Institute and the Institute of Soil Study of the Academy of Sciences of the U.S.S.R. and in other institutes. Research carried on in the Biogeochemical Laboratory and the researches of another Soviet geochemist, A. Fersman, published in his comprehensive work "Geochemistry" (1933–39) laid the foundation of geochemistry, of its zone of hypergenesis. In 1937 another of the founders of geochemistry, V. M. Goldschmidt, of Oslo, pointed out the significance of the work done by Vernadsky's school on the geochemistry of alluvial soils, and included them in his plan of experimental work.

Soviet men of science working in this field were mainly interested in the study of the laws of distribution between living matter, soil, surface waters and rare and disseminated chemical elements. On one hand, this research touched on the biochemistry of these elements, established as the result mainly of the work of G. Bertrand in Paris, and in the U.S.S.R. under the influence of the geochemical work of V. Vernadsky, in the Biochemical Institute of the Ukrainian Academy of Sciences, Prof. A. Pelladin, in the Pavlov Physiological Institute, by Prof. V. Sadikov and others; and on the other hand, it developed into the biochemistry of alluvial deposits. With regard to the former, stress must be laid on the present state of the question of the chemical composition of organisms in the light of geochemical conceptions.

During the past hundred years, the idea has developed that organisms consist of a limited number of certain chemical elements known as the biogenic elements. Completely new data on the systematic presence in organisms, in addition to others in soils and alluvial deposits, of bromine, iodine, fluorine, rubidium, lithium, nickel, cobalt, vanadium, titanium, molybdenum, lead, copper, strontium, barium, boron, radium and other strongly radioactive elements, the discovery of the rare elements germanium, gallium, niobium, selenium, chromium, zirconium and many others, found by and published in the papers from Vernadsky's school (A. Vinogradov, S. Borovik, V. Baranov, L. Selivanov, D. Maliuga, S. Sinyakova and others), enable us to put the question differently nowadays, and no longer to speak of which elements go to make up a living organism but rather of which elements have not yet been discovered in organisms; among these are indium, hafnium, niobium, tantalum, tungsten, radium and tellurium elements of the platinum group, although they have not yet been systematically sought. From a geochemical point of view, therefore, the organism and its environment are connected by the common history of all chemical elements. The question of the quantitative chemical composition of living matter and of various types of organism is therefore one of great interest. Here we will confine ourselves to the presentation of the geochemical curve of the distribution of chemical elements in organisms, which to some extent sums up our knowledge of this subject. The regularities observed in the average quantitative chemical composition stand out clearly when we compare the character of the curve with the character of analogous geochemical curves for soils and the earth's crust.

In general, the average chemical composition of organisms is reminiscent of the composition of soils forming the earth's crust. Chemical elements of low atomic number predominate. The position of certain chemical elements on that curve, lower or higher in comparison with the curve for soils and the earth's crust, may be explained by geochemistry. At the maxima of the curve we find those chemical elements which under biosphere conditions form easily moving compounds, gases, soluble salts, etc.; while chemical elements at the minima of the curve do not form such compounds, as, for example, scandium, tin, titanium, hafnium, zirconium, thorium and many others. In spite of the frequently high content of the latter elements in soils and rocks, their content in organisms is one thousand to one ten-thousand times smaller. So far as the former are concerned, the concentrators are known; organisms in certain districts are greatly influenced by the insufficiency or abundance of these chemical elements in their environment.

That very brief and general outline of the geochemical data of organisms with average chemical composition, the collection of which required a tremendous amount of labour and knowledge, must now serve as the basis for a theory of the comparative elemental composition of various species and the evolution of their chemical composition. These data show that the chemical composition of organisms is one of the distinguishing features of species.

The attention of Soviet investigators has been directed towards endemic diseases of plant life, animal life and man. Thanks to the expeditions of the People's Commissariat of Health of the U.S.S.R., the Biogeochemical Laboratory of the Academy of Sciences has at its disposal a considerable amount of material concerning the distribution of iodine in organisms, waters and soils from places with endemic goitre (the following were investigated: Kabardino-Balkaria, Azerbaijan S.S.R., Mari A.S.S.R., Karelian A.S.S.R., Eastern Siberia and other districts of the Soviet Union). The data on iodine served as a basis for the systematic iodine treatment of the population which was carried out by the People's Commissariat of Health. These data enabled us to investigate the causes of an insufficiency of iodine in these districts. Similar geochemical research was carried out by the Biogeochemical Laboratory in the Urov region in eastern Siberia, which shows an insufficiency of calcium; soils of the Belorussian S.S.R. were investigated for copper content, insufficiency of which leads to a stunting of grain crops; investigation of soils of the U.S.S.R. in connexion with an insufficiency of boron leading to plant diseases, and a study of the flora in regions with excessive selenium content in the soil, etc. Investigations of this nature have enabled us to establish that at least twenty or thirty similar endemic diseases are connected with insufficiency or superfluity of certain chemical elements in the environment and have laid a scientific foundation for measures to be taken (A. Vinogradov).

Flora and fauna passing through such biogeochemical provinces are subjected to the specific influence of this insufficiency or superfluity of certain chemical elements. Some species acquire, as might have been expected, a certain physiological tolerance, as for example, tolerance to superfluous quantities of copper, nickel, lithium, etc., and form, apparently, races with a high content of these elements, whereas others die out. The question which has now arisen is whether certain species, concentrators of various chemical elements (for example, plants with high lithium content described by Vernadsky's school, plants rich in boron, plants concentrating molybdenum, etc.), came originally from similar biogeochemical provinces, and whether they show by their chemical composition signs of their origin.

As we have already said, the other side of the work of Soviet biogeochemists concerns problems connected with the geochemistry of alluvial deposits and rocks. It is, therefore, natural that sea deposits and the present geochemical processes going on in the depths of the sea should attract them. These researches have been developed side by side with oceanographical work in our seas, work which has been carried on at the State Oceanographical Institute. A. Arkhangelsky has carried out extensive research on the presence of, and changes in, organic matter in Black Sea alluvial muds in connexion with the formation of oil deposits, the Oceanographic Institute has worked on the problem of obtaining a clear picture of the distribution of organic matter in the Barents and other Soviet seas; finally, a balance has been drawn up of organic matter, nitrogen and phosphorus in the Caspian Sea (S. Bruyevich). These and other similar investigations are all component parts of one and the same old, but nevertheless perpetually new, practical and very important problem of the fate of organic matter in the sea.

Sea organisms take part in a number of exceptionally many-sided geochemical processes, as was shown in A. Vinogradov's paper "The Chemical Elemental Composition of the Sea". Here I can only mention a few new and more important facts and conclusions in this respect. It has been proved that the concentration of iodine by seaweeds and still more by plankton diatoms creates the necessary condition for an accumulation of iodine in sea muds. During the process of the metamorphosis of muds, the iodine enters into solution with the water, forming strata of mineral iodine-bromide waters, which have considerable regional distribution and are a source of commercial iodine.

It has been further shown, for example, that exceptional concentrations of vanadium are deposited on the sea bed by Ascidians and are accumulated in the sea muds when the organisms perish. Radium and many other widely disseminated chemical elements are extracted from sea water by organisms. Research into the influence of organisms on the natural radioactive balance has shown in particular that various radioactive elements in the environment may be transformed into equivalent radioactive quantities (with equal number of disintegrating atoms), the absolute concentration of radioactive elements being changed a million times (V. Baranov).

The study of the migratory routes in the sea of boron, lithium and rubidium, which in general repeat the history of potassium, the picture of their dissemination given in the works of L. O. Solivanov, shows that although these elements are concentrated by organisms, in the final analysis they saturate and are accumulated in alluvial soils through water solutions in the form of chemical deposits. This is also to a considerable degree true of the formation of deposits of strontium and thorium salts occurring, for example, in the form of facies with celestite and rathite in the depths of the Permian Sea.

The formation of phosphate facies (and the formation of phosphorites) has been explained by A. Kazakov, also on the basis of research into the equilibrium of dilute solutions containing calcium and phosphate, as the appearance in water at certain depths in the zone of regeneration of organic phosphorus, deposits of calcium phosphate and apatite.

A few words about organogenic rocks. Thanks to the systematic study of the ashes of oils and solid bitumens, we have been able to discover the existence of oil-bearing regions where all the bitumens contain vanadium. The oils and hard bitumens of Baku, Grozny and other Caucasian oil-fields are practically free from vanadium. Nor, apparently, do the bitumens of Emba concentrate vanadium. The oils and asphalts of the Volga-Ural provinces, on the other hand, are extremely rich in vanadium, their vanadium content in some cases, for example in the ashes of Sadkin asphalt, being as much as 75 per cent V_2O_5. Priperchorsky district has oils with similar vanadium content.

On the basis of these geochemical data we may formulate the hypothesis that vanadium was selected from alluvial deposits in the sea by the primary matter of oil. The presence of vanadium, on account of its marked catalytic character, determines the later character of the oil, which as a rule has an asphalt base with a high sulphur content (A. Vinogradov).

At the same time, coal has been found with a large germanium content. All this has given us reasons for investigating the processes of the accumulation of rare elements in coal with the object of searching for industrially useful concentrations (Biogeochemical Laboratory: S. Borovik, V. Ratynsky and others).

As a result of the accumulation of considerable data on the distribution of rare and widespread chemical elements in soils and strata, and the geochemical explanation of the history of these chemical elements, a method of correlation or indication of separate geological provinces in accordance with the distribution of microelements in them has been established. This opens up extensive prospects in the problem of drawing up a geochemical map of ancient processes in the earth's crust. Publications which have appeared during recent years on researches into the geochemistry of isotopes of the light elements have the same object (V. Vernadsky, P. Teis, A. Brodsky).

AN ATTEMPT AT A NATURAL CLASSIFICATION OF THE STEROIDS

By Prof. HANS SELYE
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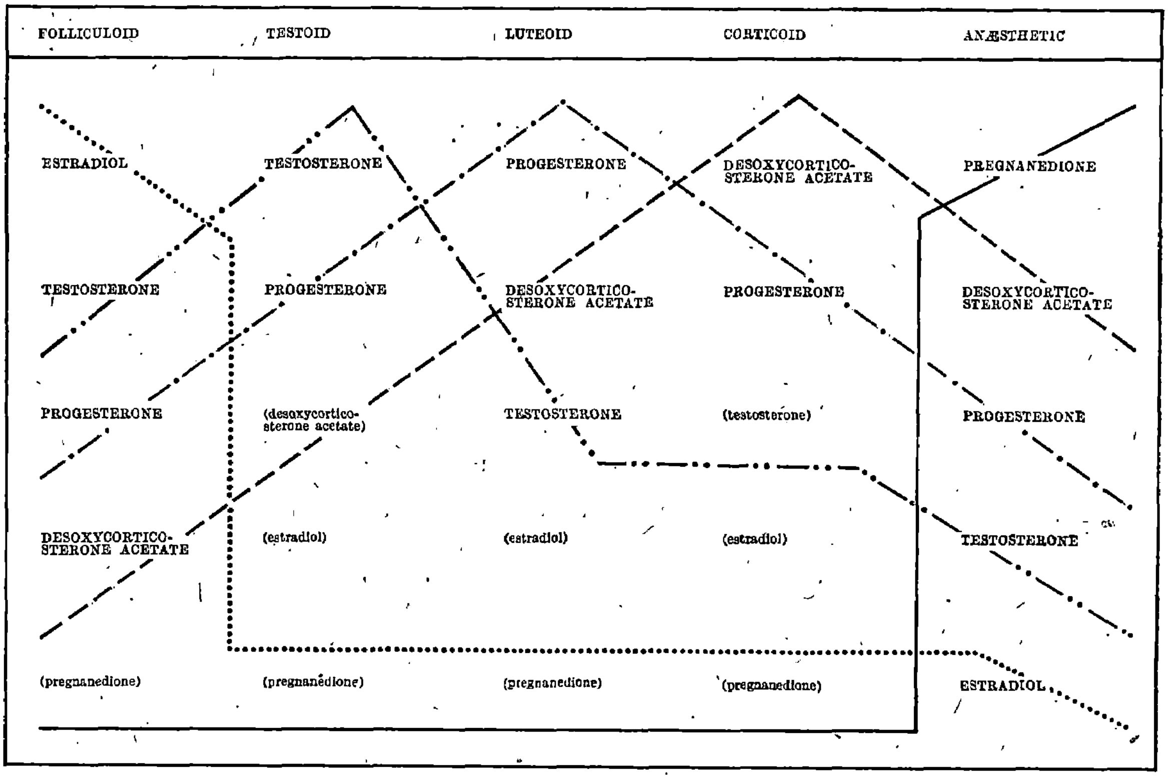
THE manifold and overlapping activities of hormonal steroids tend to give the impression that there is no orderly pharmacological correlation among them. It is known that testoid or 'male' compounds may have folliculoid or 'female' hormone-like activities, that adrenal steroids may imitate the hormone of the corpus luteum, and so forth. An additional complication has recently been introduced by the observation that under suitable experimental conditions all steroid hormones exhibit anæsthetic properties.

Systematic Table of the Steroids.



FOLLICULOID	TESTOID	LUTEOID	CORTICOID	ANÆSTHETIC
ESTRADIOL	TESTOSTERONE	PROGESTERONE	DESOXYCORTICOSTERONE ACETATE	PREGNANEDIONE
TESTOSTERONE	PROGESTERONE	DESOXYCORTICOSTERONE ACETATE	PROGESTERONE	DESOXYCORTICOSTERONE ACETATE
PROGESTERONE	(desoxycorticosterone acetate)	TESTOSTERONE	(testosterone)	PROGESTERONE
DESOXYCORTICOSTERONE ACETATE	(estradiol)	(estradiol)	(estradiol)	TESTOSTERONE
(pregnanedione)	(pregnanedione)	(pregnanedione)	(pregnanedione)	ESTRADIOL

However, certain regularities are detectable. Thus it has been shown that some steroid hormone actions are independent of each other, while others are strictly interdependent. The folliculoid, testoid, luteoid, corticoid, anæsthetic, renotropic and spermatogenic activities all have proved to be independent of each other inasmuch as there is no parallelism in the ability of compounds to exhibit these various effects. On the other hand, such responses as vaginal cornification, uterine enlargement, testis atrophy and the cure of castration changes in the hypophysis are all subordinate to the folliculoid action. Hence the degree to which a compound is able to exhibit any one of these effects is proportionate to its other folliculoid activities. Similarly the comb-growth effect, as well as the stimulation of the seminal vesicles and prostate, are subordinate to the testoid action, and so forth. There is no such parallelism in the degree to which a compound exhibits any two of the so-called independent actions. However, even among these, only the folliculoid and anæsthetic potencies are ever demonstrable in a steroid in the complete absence of all other hormonal effects. Furthermore, with the exception of the purely anæsthetic compounds, all hormonal steroids exert some degree of folliculoid activity, and conversely, all hormones are active as anæsthetics.

It has now been observed that the above rules, as well as other regularities among the steroids, can readily be visualized by their classification into the systematic table shown below. The most active representatives of five independent actions have been selected and arranged from left to right according to decreasing order of folliculoid potency. (Since the most potent representatives of the renotropic and spermatogenic series have not been definitely identified as yet, these actions are not considered here. However, according to the folliculoid effect of the known prominent representatives of these groups, they should both be inserted next to testosterone.) It will be noted that the folliculoid activity of all these compounds, except estradiol, is 'masked' and detectable only under certain experimental conditions. Furthermore, for the purpose of this discussion prostatic enlargement is considered sufficient for the demonstration of testoid activity. The potency ratings for folliculoid[1,2], testoid[3], luteoid[4], corticoid[5,6,7,8] and anæsthetic[9] activities have all been taken from publications based on assays performed before this system was devised. Desoxycorticosterone acetate has been chosen as the most active representative of the corticoid series as it is the only highly active member of this group which has been adequately studied for all five independent actions. In each column representing a certain type of activity the inert compounds are inserted in brackets below the active compounds of the group. When the steroids are so arranged according to decreasing folliculoid activity in the first line of the table, the most active representatives of the folliculoid, testoid, luteoid, corticoid and anæsthetic compounds appear in the order stated. The second most active representatives of each of these five activities were placed in the second line, third place being given to the next most active compounds, and so forth.

Perusal of the table indicates that, if the steroids are arranged in the first column according to decreasing order of folliculoid activity, they are automatically in increasing order of anæsthetic potency. The position of each steroid was traced by a line through the five columns. This revealed that estradiol and pregnanedione are at the bottom of the graph, except in the column in which they are placed on top as the most active folliculoid and anæsthetic compound respectively. The three remaining compounds slowly lose height in both directions with approximately the same slope. Thus the curve described by the position of any steroid in the table exhibits a single maximum.

Prof. D. L. Thomson kindly analysed these data in order to determine whether the apparent 'orderliness' is statistically significant. Disregarding all possible *a priori* arguments from chemical relationships he found that the regularities observed in the whole scheme—allowing for the selection of the top entry in each column and giving no 'credit' for possible orderliness in the compounds found inactive in each type of test—would occur by chance only in 1 out of 2,304 trials. Hence it may be said that this particular arrangement is not due to chance, but is apparently dependent upon certain inherent natural relationships between the steroids.

The table also expresses the empirical fact that only folliculoid or anæsthetic potencies may be exhibited to the exclusion of all other independent actions, since these two are on the outer limits of the system and hence do not have to overlap with other effects. Compounds not included in this table also obey the same rules although, of course, depending upon the degree of their potency they range above or below the curves given here. Thus ethinyl-estradiol, which is somewhat more folliculoid than estradiol, describes a line parallel with that of estradiol although somewhat higher than the latter, while pregnenolone, a compound having an activity which is qualitatively similar but quantitatively inferior to that of progesterone, parallels the curve of the latter at a somewhat lower level. Acetoxy-pregnenolone, a comparatively inactive corticoid[6], parallels the desoxycorticosterone acetate curve in a similar manner, and so forth. Among all steroids studied no exception could be found to the rule that all compounds describe curves with a single maximum when inserted in this system. The main weakness of the classification so far detected is that the activity curve of a certain compound may skip one or more points on the curve, perhaps because this particular action is so 'masked' that it is not detectable with our bio-assay methods.

The biological significance of these correlations among the steroids is not easy to interpret. It may be that the molecular structure necessary for any one activity necessarily carries within itself other pharmacological properties and that the intensity of these decreases in direct proportion to their distance from the primary activity in the table. It is also possible that the compound placed at the peak of any one curve is partly transformed in the body into compounds with neighbouring actions which in turn yield smaller amounts of steroids in the columns next to them. Thus the degree of activity would gradually diminish in proportion to the distance in the table from the position of the original compound injected. In this sense the pure folliculoids and anæsthetics might be considered as metabolic end-products incapable of re-transformation into compounds occupying more central positions in the table. This is graphically expressed by their marginal position and the steep curve which separates them from neighbouring activities. In connexion with the observation that a compound may skip a point on the curve, we must consider the possibility that certain steroids may go through a pharmacologically inactive stage during their metabolism.

Considering the limited data available at this time, it would scarcely be justified to base any far-reaching speculations on the regularities observed. The only purpose of this communication is to direct attention to the fact that if the steroids are arranged according to the degree of their folliculoid activity, they fall into a system which permits—within limits—a prediction of their other activities.

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ORIGIN OF COSMIC RAYS

By Dr. R. A. MILLIKAN, Dr. H. V. NEHER
and Dr. W. H. PICKERING
Californian Institute of Technology

THE hypothesis here adopted as to the mode of origin of the cosmic rays makes possible the prediction of five definite vertically incoming cosmic-ray bands. As the observer moves north from the magnetic equator, each of these five bands should begin to reach the earth at a particular latitude and continue reaching it at all more northerly latitudes. Between each latitude of first entrance of a band of particular energy and the latitude of first entrance of the band of next lower energy, there should be found a plateau of constant vertically incoming cosmic-ray energy. Four such plateaux should be experimentally observable.

The hypothesis rendering possible these predictions rests upon five major discoveries[1]:

(1) The proof by Millikan and Neher that more than 60 per cent of all incoming cosmic-ray energy is of the nature of incoming charged-particle bullets, each of energy between 2 billion electron volts and 15 billion electron volts.

(2) Neddermeyer and Anderson's discovery of the production by nuclear impacts within the atmosphere

of mesotrons which serve as the chief carriers of the cosmic-ray energy down to the lower levels of the atmosphere.

(3) Bowen's remarkable discovery that atoms, when out in interstellar space, are able to undergo atomic transformations forbidden to them within the stars.

(4) Bowen and Wise's discovery that in ring-nebulæ, trillions of miles away from the exciting star and therefore presumably reflecting conditions in interstellar space, there are five of the atoms, namely, helium, carbon, nitrogen, oxygen and silicon, each of which is more than ten times more abundant than any other atom save hydrogen (which must be excluded from measurable cosmic-ray effects because of the smallness of its rest-mass energy).

(5) Lauritsen and Fowler's discovery in the Kellogg Radiation Laboratory that a part, at least, of the rest-mass energy of an atom has the power under suitable conditions of transforming itself *directly* into the creation of a positive-negative charged-particle pair.

The hypothesis made in view of these five discoveries is that, while the evolution of energy by the stars is maintained, as Bethe has recently shown, by the *partial* transformation within the stars of the rest-mass energy of hydrogen into radiant energy through the building of helium, carbon and other atoms out of hydrogen, and the release through this process of the so-called 'packing-fraction' energy, the energy of cosmic rays, on the other hand, is maintained by the occasional *complete* transformation in interstellar space of the rest-mass energy of the atoms of helium, carbon, nitrogen, oxygen and silicon (and presumably in small amounts of heavier aggregates) into cosmic rays; each such event presumably creating an electron pair, though an occasional photon pair, or even heavier-particle-pair, need not *necessarily* be excluded.

The foregoing hypothesis requires that the cosmic rays of measurable energy reveal a spectral distribution of five distinct, definitely measurable bands as follows: (1) a band of rays each having an energy of 1·9 billion electron volts produced by the annihilation, or complete transformation, in interstellar space of the rest-mass energy of the helium atom; (2) a carbon-atom-annihilation band of energy 5·6 billion electron volts (b.e.v.); (3) a nitrogen-atom band of energy 6·6 b.e.v.; (4) an oxygen atom band of energy 7·5 b.e.v., and (5) a silicon atom band of energy 13·2 b.e.v.

The hypothesis requires, further, that there should be in India for vertically incoming rays between the magnetic equator and magnetic latitude about 20° N. a plateau of unchanging cosmic-ray intensity with latitude. This plateau our experiments in India in 1939–40 brought to light, also the appearance between Agra (17·3° N. Mag.) and Peshawar (25° N. Mag.) of a new cosmic-ray band which we identified with the silicon band of energy 13·2 b.e.v. These results have already been reported[2], and in that report we promised further tests of the hypothesis in Mexico and the United States. In spite of our absorption in war-work we succeeded in December 1941 and March 1942 in making these tests with the following results, which are reported in full in the *Physical Review* of April 1–15, 1943.

(1) *Tests in Mexico.* We had predicted that since the hypothetical silicon-annihilation rays should have enough energy (13·2 b.e.v.) to get vertically through the earth's magnetic field at the equator in Peru, though not in India, there should be found, both at sea-level and at all altitudes in the Americas, when vertically incoming rays alone are under test, a very long plateau of uniform cosmic-ray intensities extending north from Mollendo, Peru, to about the latitude of Victoria, Mexico (mag. lat. 32·8°). There the strong band due to oxygen-annihilation rays (7·5 b.e.v.) should first appear, to be followed in going still farther north when the latitude of 40° N. magnetic had been reached, by the full entrance of the nitrogen-annihilation band (6·5 b.e.v.). *The experimental findings were in accord with these predictions.*

(2) *Tests in the United States.* In going from Pasadena (mag. lat. 40·7°) to St. George, Utah, but 4·1° (280 miles) nearer to the north magnetic pole than Pasadena, the carbon-annihilation band (5·6 b.e.v.) was expected to appear, to be followed by a flat plateau clear up to latitude 54° N. magnetic, when helium-annihilation rays (1·88 b.e.v.) were expected to appear. A balloon flight at St. George (mag. lat. 44·8°) and another at Pocatello, Idaho (mag. lat. 51°) yielded preliminary results in harmony with these predictions.

(3) *Evidence that the act of atom-annihilation actually transforms the rest-mass energy of an atom into an electron pair.* The flat plateau between St. George and Pocatello (mag. lat. 51°) corresponding to the absence of abundant atoms of atomic weight between that of carbon and that of helium, and the definite appearance of a new band between Omaha (mag. lat. 51·3°) and Bismarck (mag. lat. 56°), constitute new and strong evidence for the transformability of the complete rest-mass energy of an atom into an electron pair.

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SIR DAVID GILL, K.C.B., F.R.S., 1843–1907

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

JUNE 12 is the centenary of the birth of Sir David Gill, who has been called "the greatest Scottish astronomer of his generation". Born in Aberdeen and educated at the University there, where he came under the influence of Maxwell, he early abandoned a lucrative business career for the life of an astronomer, and eventually gained a world-wide reputation among his fellows.

Gill made his first observations in the small observatory at King's College, Aberdeen; afterwards he erected a reflector in the garden of his father's house, and then in 1872, at the age of twenty-nine, became the first director of the Dunecht Observatory erected by Lord Lindsay, afterwards the Earl of Crawford. In 1874 he organized and accompanied Lord Lindsay's expedition to Mauritius to observe the Transit of Venus. His next expedition was to Ascension, which he visited in 1877 with the object of determining the solar parallax from measures of the parallax of Mars at its nearest to the earth.

His work during these expeditions was so notable that in 1879 Gill was appointed to succeed E. J. Stone as "Her Majesty's Astronomer" at the Cape of Good Hope. This position he held until 1906, raising the reputation of the Observatory and playing a part in many important undertakings. A successful photograph of the great comet of 1882 suggested to him the practicability of mapping the whole sky, resulting ultimately in the inauguration of the great

International Astrographic Chart and Catalogue at the Paris Congress of 1887. Of this work Gill said in 1907: "A century hence this great work will have to be repeated, and then, if we of the present day have done our duty thoroughly, our successors will have the *data* for an infinitely more complete and thorough discussion of the motions of the sidereal system than any that can be attempted to-day".

Another scheme of Gill's was the measurement of the Great African arc on the 30th meridian. So early as 1874, after his visit to Mauritius, at the invitation of General Stone, chief of the military staff of the Khedive, he had measured a base-line for a proposed survey of Egypt, and once settled at the Cape he took up the question of a geodetic survey of South Africa. It became the dream of his life to see the completion of the measurement of an arc from Cape Agulhas to Cairo, whence the measurement would be carried by the eastern shore of the Mediterranean and Greece to meet Struve's great arc which extends to North Cape.

But while it was these and other labours of a kindred nature which occupied Gill's time and raised him to a leading position in the astronomical world, his success was to a large extent due to his simple, direct and energetic character. As his biographer in the Report of the Council of the Royal Astronomical Society for 1915 said: "Those who came in contact with him felt the charm of his personality. In some indefinable way he could inspire others with his enthusiasm and determination. Enjoying a life crowded with activity, surrounded by an unusually wide circle of friends, he was ever ready and eager to encourage the humblest beginner." Settling in London after his retirement from the Cape, he did valuable service for various scientific societies, and in 1913 he published his "History and Description of the Cape Observatory".

Gill was elected a fellow of the Royal Society in 1883 and made K.C.B. in 1900. He fell ill with pneumonia in December 1913, and died on January 24, 1914; he was buried at Aberdeen.

OBITUARIES

Mr. Lionel R. Crawshay

Mr. L. R. Crawshay, who died suddenly at Plymouth on April 24, was born at Honiton on July 9, 1868. He was educated at Harrow and Brasenose College, Oxford; he graduated in arts, but later took up natural science, studying under Prof. Minchin at University College during 1903–5. He was then appointed assistant naturalist to the Marine Biological Association under Dr. E. J. Allen, a post which he held until 1914. During the War of 1914–18 he served as a trooper in the First King Edward's Horse and as instructor in computation, Field Survey Co., R.E. In 1919 he was awarded a Ray Lankester investigatorship at the Plymouth Laboratory, but shortly afterwards he was selected for a Colonial Office appointment as research officer, Sponge Fishery Investigations. The post was a temporary one, at Nassau in the Bahamas, and was originally for one year only; but Crawshay quickly proved his capacity and the appointment was repeatedly extended until his service had reached a total of fifteen years. He worked for some time in British Honduras, living in primitive conditions on a reef adjacent to the sponge fisheries, and in 1930 he was deputed to report on the sponge industry in Cyprus. He retired in 1934, and during the remainder of his life he worked regularly at the Plymouth Laboratory, continuing his researches on the Porifera with unabated enthusiasm.

It is greatly to be regretted that so little of Crawshay's unrivalled knowledge of sponges and sponge culture has been published. The results of his long years of work in the West Indies and British Honduras were sent as official reports to the Colonial Office and none of them has been printed. His report on the Cyprus industry has, however, been published, and one paper, intended as the first of a series, which he wrote after his retirement. Throughout his life he was interested in entomology, in which his brother, the Rev. G. R. Crawshay, did most useful work; in 1903 he published a detailed account of the development of Drilus (Coleoptera) and he made valuable observations (not published because he regarded them as incomplete) on certain Dartmoor Coleoptera. He wrote on the arterial system of the Anura, contributed short papers on a variety of subjects to the *Journal of the Marine Biological Association*, and reported on the microplankton obtained by the *Scotia* in a voyage which he himself accompanied in 1913.

Crawshay was a keen lover of Nature at its wildest. He delighted in solitary tramps across the remotest parts of Dartmoor, and spoke with such enthusiasm of his work abroad that it may be doubted whether he ever felt the extreme loneliness of his life on the sponge lagoons. As a scientific worker he had outstanding qualities, observing and recording with scrupulous accuracy and exercising the greatest caution in his deductions. He devoted himself to his work to the exclusion of every other thought, and had no regard whatever for his own material comforts. To all at the Plymouth Laboratory he endeared himself by his modesty and charm of manner and by his constant thoughtfulness for others.

S. Kemp.

Dr. H. Gordon Rule

Dr. H. Gordon Rule, reader in the Department of Chemistry at the University of Edinburgh, died on March 15, at the age of fifty-five. After graduating with honours in chemistry at Birkbeck College, London, he carried out research with Prof. Alex McKenzie and then worked for two years under Otto Dimroth in von Baeyer's laboratory in Munich, where he gained his Ph.D. in 1912. Returning to Great Britain, Rule spent a year at Birkbeck College and in 1913 went as an assistant to the University of Edinburgh. In 1921 he was appointed senior lecturer in organic chemistry, a position he held until his death. He was made reader in 1939.

Much of Rule's time was devoted to research, but he never neglected his teaching duties. He was an excellent teacher and his lectures were models of clearness and conciseness, while his quiet humour added to his popularity with the students. It was the same at the Chemistry Colloquium: a 'full house' was assured if Rule was the speaker.

Rule's main research work extended over a period of twenty years and dealt with the factors governing the magnitude of optical rotatory power, a problem which had earlier attracted the attention of another Edinburgh chemist, Crum Brown. Rule published more than thirty papers on this subject and established the important part played by the polar groups in the asymmetric molecules and in the solvent employed. Later he turned to quite a different line of research and made some notable contributions in the rather ungrateful field of benzanthrone chemistry. Before the end, however, he returned to his first love, stereochemistry, and with G. M. Henderson published an account of the resolution of an organic racemic compound by chromatographic adsorption.

No record of Rule's work would be complete without reference to his admirable translation of the well-known German text-book, Julius Schmidt's "Kurzes Lehrbuch der Organischen Chemie", the fourth edition of which was in the printer's hands when Rule was overtaken by the illness to which he succumbed. His extensive alterations and improvements of the original text undoubtedly contributed much to the success of the volume in Great Britain.

All Rule's work was characterized by orderliness and neatness and his motto might well have been the dictum of Hofmann, "Ordnung ist die halbe Chemie". The value of his researches was widely recognized and his death will be keenly felt.

NEIL CAMPBELL.

NEWS and VIEWS

Royal Botanic Gardens, Kew: New Director

Prof. E. J. Salisbury, C.B.E., F.R.S.

THE appointment of Prof. E. J. Salisbury as director of the Royal Botanic Gardens at Kew will give general satisfaction. Like one of the most successful of its directors, Sir William Thiselton Dyer, Prof. Salisbury began his career as a teacher of botany, having held with distinction the Quain professorship of botany in University College, London, for many years. His earlier interests in botany were in the field of plant ecology, to which he made a number of first-rate contributions. His study of the vegetation of Blakeney Point, Norfolk, led him to take a special interest in the distribution of plants in the neighbouring parts of the country and resulted in an excellent account of the East Anglian flora published in the *Transactions of the Norfolk and Norwich Naturalist Society*. His work on the distribution of plants directed his attention to the gradual disappearance from some of our counties of many interesting plants, and his account of the "Waning Flora of Britain" expresses his concern in the matter, and has caused him to take an active part in the preservation of the flora of Britain.

Always a keen and successful gardener, Prof. Salisbury's "Living Garden" embodies the why and wherefore of his success and gained for him the recognition of the Royal Horticultural Society. During the War, he was elected to the Agricultural Research Council and his scientific knowledge joined to his horticultural experience has enabled him to play an important part in the solution of many horticultural problems. By Prof. Salisbury's appointment to Kew, the Gardens will not only gain a director with a wide outlook, who will ensure the continuance of the good work of the Herbarium and the advisory work to the Colonial gardens, but his horticultural experience will enable him to carry on successfully the cultivation of the collection of living plants and will lead, it is to be presumed, to some experimental work both in the cultivation of plants and in plant genetics.

King's Birthday Honours for Canadian Services

A SEPARATE list of honours conferred by the King "on the occasion of the celebration of His Majesty's birthday and on the advice of Canadian Ministers", includes the following names: *C.M.G.:* Prof. C. J. Mackenzie, acting president of the National Research Council of Canada; Prof. W. G. Penfield, head of the Neurological Institute, Montreal. *C.B.E.:* Dr. A. E. Archer, president of the Canadian Medical Association; Prof. J. B. Collip, president of the Royal Society of Canada; W. E. Phillips, president of Research Enterprises, Ltd.

Association of Scientific Workers: Council Meeting

THE twenty-sixth council meeting of the Association of Scientific Workers was held in London during May 8 and 9. A rapid growth in membership was recorded, the present total being more than 11,000. The most important organizational development during the past year was the decentralization of much of the work of the Association to area committees, nine of which have been formed to co-ordinate the work of the 148 branches. As a result of this, area offices have been opened in London and Manchester. It was decided that in future half the executive committees would be elected as representatives of the areas. After debating internal matters, the Council instructed the executive committee to "carry out a nation-wide campaign to draw the attention of all citizens to the contributions to human welfare which science can make if properly planned, adequately financed, and applied solely for the good of society". It approved the principle of a State Medical Service, and urged the rapid extension of the use of mass radiography. Many aspects of science education were debated, and changes in university curricula to enable students better to meet present industrial requirements were recommended. The need for employees to have opportunities for part-time study was stressed, and the executive committee was asked to "obtain from the Board of Education a definite undertaking (on the lines of that given by the Canadian Government) that students trained under special war-time schemes in Universities and Training Colleges will be accorded adequate post-war facilities for the completion of their education". Support was given to the broad principles embodied in the T.U.C. Memorandum on Education. The council reaffirmed its views that a central planning board was necessary to obtain the maximum utilization of scientific and technical resources, and urged that scientific knowledge should be used on joint production committees by allowing the technical staff to be represented. The Beveridge Report was discussed by the delegates, who welcomed "the adoption in the Scheme of scientifically determined standards of human needs". The president, Sir Robert Watson-Watt, the hon. general secretary, Dr. W. A. Wooster, and the treasurer, Dr. S. Masterman, were re-elected to hold office for the coming year. The Association has just published the full proceedings of the Conference on "Planning of Science" held during January 30–31.

Aims of the Association

FOR his presidential address to the Association, Sir Robert Watson-Watt took as his theme the topic of contentment. The Association, he pointed out, is now strong, but still not fully representative of scientific and technical workers as a whole. Nevertheless, it is strong enough to be able to admit misunderstanding of its objects. One charge brought against the Association is that it is more concerned with politics than science; this suggests that some people do not realize how fundamental politics is. Scientific workers are citizens, and as such they should be profoundly concerned with the application of science to the good of the State and of the world. Politics means publicity, and so the Association must of necessity undertake to influence public opinion. The social relations of science is a primary object of study for the Association, but propaganda and economic and engineering efficiency play equal parts in its trade union activities. It has been said the Association fosters enmity between juniors and seniors. Sir Robert takes the view that the enmity already exists, though to a diminishing extent, and he is all for bringing it out into the open and treating it by free discussion. Seniors who make this charge are suffering from the dread disease of contentment. The last charge he discussed was that the Association consists of idealists. To the extent that we all believe in the possibility of making a better world, we are dealists. But Sir Robert was scathing in his comments on dangerous idealists of industrial research aboratories, who declare that the methods of the Association have brought discord between laboratory taff and management; they indeed are suffering from contentment, or even complacency, which may easily come to mean smugness.

Anglo-Czechoslovak Chemical Collaboration

THE need for closer collaboration between British nd Czechoslovak chemists was stressed at a meeting under the auspices of the Association of Czechoslovak Scientists and Technicians Abroad held at the Czechoslovak Institute, Grosvenor Place, London, on May 14. It was attended by Czechoslovak chemists erving or working in Great Britain and by members f the five British chemical societies, and was addressed by Dr. G. Druce and by Dr. George Lewi, chairman of the chemical group of the Czechoslovak Association. Dr. Druce briefly described some of the ontributions of Czechoslovak chemists to the advancement of science, particularly during the two decades between 1918 and 1938. Reference was also made o the importance attached by Czechoslovak educaional authorities to science and scientific research, specially in chemistry. There is a relatively extensive scientific and technical literature, and zechoslovakia possessed many public and corporate research institutes in connexion with the country's ugar, glass, brewing, mining and metallurgical ndustries and with agriculture and forestry. The German occupation of Czechoslovakia and the closing of the universities, etc., has interrupted the investigations in progress under Czechoslovak men of science, but with such a tradition as they possess, the nation's chemists and technologists will doubtless resume and extend their peaceful activities as soon as the country regains its independence. In this work British chemists will watch with interest the efforts to reconstruct the chemical and other scientific institutions and the industries they serve.

Dr. Lewi gave an impressive account of his country's chemical industry, the extent of which has not been realized abroad. The output was very great and included a long list of varied types of products. Nevertheless, Czechoslovakia imported considerable quantities of chemicals and similar products. Hitherto these had come mainly from Germany. Again, although Czechoslovakia's natural resources are great and include most metal ores as well as coal, lignite, graphite and pitchblende and also timber, they were insufficient for local needs and more had to be imported. In particular, the chemical and allied industries would need financial and technical assistance for the reconstruction that would take place in the post-war years. This help could best come from British sources, to which Czechoslovak chemists look for guidance in the difficult times ahead. Many industries would be left in ruins by the Germans, who had already pillaged both private industrial undertakings and public scientific institutions. Dr. Lewi took the opportunity to agree with Sir Robert Robinson's contention that the German chemical industry must not be allowed to menace mankind in the future. In the meanwhile, the Czechoslovak chemical community in Britain places its knowledge and experience at the disposal of the common cause, and at the same time attempts to assist its members and student nationals to prepare for the tasks that lie before them when they return to their liberated homeland.

Reconstruction in the Birmingham Area

SPEAKING to the Birmingham General Branch of the Association of Scientific Workers on June 1 on "Reconstruction in Birmingham and the West Midlands", Councillor Paul Cadbury outlined the original research work which is being done by a group of paid and voluntary workers connected with the University of Birmingham under the chairmanship of Dr. R. E. Priestley and the technical direction of C. B. Parkes of the Bournville Village Trust. Surveying the five counties forming the Midland Civil Defence Region, by excluding land of various categories (for example, inaccessible, marshy, highly fertile, and of great natural beauty) there remains only a very restricted number of areas suitable for future industrial and urban development. In some cases these happen to adjoin existing market towns (for example, Bridgnorth) which have facilities and services particularly suitable for an increased population. Before the publication of the Uthwatt Report, Mr. Cadbury said that State ownership of all land was recommended as ideal, with the vesting in the State of the development rights of all land as an immediate necessity. In rebuilding, existing towns should be broken down where possible into 'neighbourhood units', each with its own community centre and group of industries. Large dormitory suburbs and dependence on only one industry would thus be avoided. The whole talk provided an excellent example of realistic application of the scientific method of planning to a social problem.

An Army Nature Observation Scheme

The new Army Nature Observation Scheme has as its first object co-operation in the national wood pigeon investigation of the Edward Grey Institute at Oxford. Under this scheme, states the fifth *Wood Pigeon Bulletin*, recently issued, standard cards are being supplied to one of the Army Commands stationed in Britain through the unit education officers, who will periodically distribute, collect and return them. If the scheme shows promise of being a success in this Command it will be extended to others, and the printed cards have already been dispatched to the War Office. However, a naturalist in the Forces points out that, while the idea is most welcome, the difficulties are that everything depends upon the interest shown by commanding officers, whose power over the activities of their regiments is immense: many units, especially training ones, have little experience of the Army Educational Unit, and organized natural history work depends upon freedom from evening and week-end fatigues, while the largest number of results would be obtained if permission were gained to fill the cards during parade hours. For the bulk of the modern army there is little time or facility for much apart from soldiering, so technical is modern war.

The *Bulletin* contains interesting examinations of the sexual organs of Scottish and English wood pigeons which suggest that Scottish males develop their gonads earlier than English ones: there is the same trend among the female birds, but English birds take longer to 'catch up'. In southern England, the winter field counts suggested a low and stable population in the western portion, but quite different conditions in the middle portion with a high population, reaching its peak in January, while the eastern section, on a migration route from the Continent, had its peak figures in November, falling to a low figure in February. Counts from Scotland suggested a peak in December, whereas from England they suggested January as the peak. In Scotland the fall after the December peak was rapid, so heavy as to imply an outward movement, leaving what may be a bare resident population. In England, the January numbers suggest a sudden influx of birds.

War and Medicine

The February issue of the *Journal of Laboratory and Clinical Medicine* contains an interesting article on war and medicine by Dr. Henry E. Sigerist, professor of the history of medicine at Johns Hopkins University. He remarks at the outset that the contribution of war to medicine is first of all negative. Not only are many of the *élite* of a nation killed or crippled, but also the civilian population are liable to be affected by famine and pestilence. On the other hand, war is a stimulus to medicine both technically and socially, as it provides opportunities for experimenting on a tremendous scale such as would never be available in time of peace. This applies particularly to surgery, as was first illustrated in ancient Greece when Greek surgeons travelled with the mercenaries in the army of the Egyptian pharaoh Psammetich. War was also responsible for the erection in ancient Rome of hospitals, which were unknown in ancient Greece. War surgery was revolutionized by Ambroise Paré, who, in his work on the treatment of gunshot wounds published in 1545, showed that these wounds heal much better without the brutal treatment of pouring on them boiling oil which destroyed so much of the tissues. The part played by John Hunter in the expedition to Belle Isle in 1761 was notable, in that the British Navy had the services not only of a surgeon but also of a man of science. Hunter gained invaluable experience on gunshot wounds, which he discussed in his great work on "Blood, Inflammation and Gunshot Wounds" published in 1794.

The introduction of general anæsthesia in 1846 and of antisepsis in 1867 helped to save many thousands of lives. The work of Florence Nightingale during the Crimean War of 1853–56 was the beginning of modern nursing, just as the battle of Solferino in 1859 was the starting point of the Red Cross, due to the work of the Swiss banker Henri Dunant. The value of vaccination was conclusively shown in the Franco-Prussian War of 1870–71; in the German army, where most of the soldiers were vaccinated or re-vaccinated, there were 4,800 cases of small-pox with 278 deaths, whereas among unvaccinated French people there were 14,000 cases with 2,000 deaths. The War of 1914–18 demonstrated the importance of protecting the workers' health, and industrial medicine led to the establishment of ministries of health in various countries. In conclusion, Dr. Sigerist states that though the present War will undoubtedly stimulate medical science, its social effects will be much more strongly felt.

Cancer Control in the United States

In a recent paper (*Public Health Rep.*, **57**, 1613; 1942), Dr. A. Scheele describes the present cancer control activities conducted by thirty-nine health departments and three cancer commissions in the forty-eight States and the Territory of Hawaii. The known expenditure for programmes amounted to about 1,280,000 dollars during the fiscal year ending June 30, 1941. The activities consisted of lay and professional education, provision of diagnostic and treatment facilities, and research, primarily statistical. Interest in cancer control in the United States has rapidly increased during the last few years, and most of the new programmes have developed since 1930. It seems probable that real gains in the campaign against cancer will come through improvement and extension of current programmes. Later it i hoped that the campaign will become primarily preventive rather than curative.

Public Health in Chile

The January issue of the *Boletín de la Oficin Sanitaria Panamericana* contains an account of the state of public health in Chile by Dr. Juan Antoni Ríos, president of the Republic. With the exceptio of an outbreak of cerebro-spinal fever in Santiago and Valparaiso which has been successfully combated there has been no recent epidemic. Typhus is no longer a menace, and cases of typhoid fever hav been decreased by mass inoculation and othe measures. An efficient control of drinking water being carried out. The various mother and chil welfare services have been grouped under a Technica Advisory Division, the functions of which have bee co-ordinated with those of social security and private institutions. An eye clinic and one fo skin and venereal diseases have been complete Five institutions deal with industrial accidents.

Identification of Indian Timbers

Two leaflets have been issued by the Forest Research Institute (Pub. Forest Research Inst., Dehra Dun), on "How to Identify Timbers", Nos. 21 and 25 (Utilisation). The present War, as was the case with the War of 1914–18, has made a great demand on the timber resources of India. As the demand increases, many new or little-known timbers are being placed on the market. Considerable confusion in identity has supervened, causing perfectly good timbers for the purpose in view to fall into disrepute owing to the substitution of inferior ones. This fact has become well understood by the Defence and Supply Departments which handle timbers, and many inquiries on the subject have been put to the Institute. Leaflet (Part 1) No. 21 gives some general information on the subject of identification of timbers, well known to students of the subject. Leaflet (Part 2) No. 25 is more specialized, dealing with the identification of timbers for "Helves and Tool Handles". The leaflet gives a key for the field identification of certain timbers for tools, the demand for which in ever-increasing numbers, as is well known, has become world-wide. Short anatomical descriptions of the timbers mentioned as suitable for the purpose are included.

The High-pressure Gas-filled Cable

In a recent paper on this subject read by C. J. Beaver and E. L. Davey before the Institution of Electrical Engineers in London, the present position of existing types of high-voltage cables is briefly reviewed and the reasons underlying the development of the gas-filled cable are given. Following a brief description of the cable, the design is dealt with in detail. The construction and manufacture of the cable are then described and the physical behaviour of the cable in service is considered. Details of the accessories associated with the cable system are given, and the routine type and research testing of both cable and accessories are discussed. After dealing with gas-pressure considerations of the cable system in service and installations carried out, a brief survey of the economic aspect of the cable is given.

It is concluded that the high-pressure gas-filled cable system has certain special advantages, and that since its technical and economic positions are sound it should, in the future, be a factor to be taken into consideration when schemes involving power transmission at voltages of 33 kV. and upwards are envisaged. The design of the gas-filled cable is based upon a quantitative appreciation of the electrical and physical requirements of the dielectric of a cable to withstand service conditions without deterioration, and definite margins of safety are provided and maintained. The manufacture of the cable does not involve the use of any novel or special plant or manufacturing processes other than those which have already been in use for many years past in the manufacture of the solid-type cable. The cable system is free from external accessories, and no special arrangement is necessary if the cable is run vertically for any height or distance. The economic aspect of the cable for the voltage range of 33–132 kV. is good. The permittivity of the dielectric is a good deal lower than that of any other impregnated-paper dielectric. This is of importance in relation to the future use of higher voltage and more highly stressed cables, and the necessity of keeping the cable capacitance load on systems to a minimum value.

Earthquakes Registered at Kew

During April 1943, seven strong earthquakes were registered by the seismographs at Kew Observatory. The first of these, on April 1, was registered at 14h. 41m. 40s. U.T., and a tentative analysis puts the epicentre 15,000 km. distant. The maximum ground amplitude at Kew due to this shock was 115 μ. The second shock was on April 5. This earthquake, from an epicentre some 5,450 km. distant, recorded *ePz* at Kew at 02h. 05m. 09s. U.T. and attained a maximum ground amplitude at Kew of 67 μ at 02h. 25m. 18s. U.T. The third shock was on April 6, recording impulsively on the vertical component at 16h. 21m. 10s. U.T. It attained a maximum ground amplitude at Kew of 470 μ on the east-west component at 17h. 05m. 35s. U.T. It came from an epicentre some 11,450 km. distant, the epicentre possibly being in the neighbourhood of lat. 30° S., long. 70° W., which is in Chile. On this day a message from Santiago de Chile said that a very severe earthquake with epicentre in the Illapel zone had partly destroyed buildings in Illapel, La Serena, Combarbala and Ovalle. Further details were not given as communications with the area were severed. The fourth shock, on April 7, recorded *eP* on all three components at 09h. 03m. 40s. U.T. and a tentative analysis puts the epicentral distance at some 11,500 km. The fifth earthquake, on April 11, recorded *iP* on all three components at 14h. 58m. 43s. U.T. from an epicentre some 9,100 km. distant. Maximum ground amplitude at Kew was 170 μ on the vertical component at 15h. 41m. 17s. U.T. The sixth earthquake came from 1,800 km. away and therefore may be considered a near shock. On April 16 it recorded *iPz* at 11h. 76m. 56s. U.T. and finished recording near 12h. 25m. The seventh and last strong shock of the month was recorded on April 29. It began recording with *iP* on the vertical and north-south components at 15h. 37m. 05s. U.T. and came from an epicentre some 8,800 km. distant.

Earthquake in Colombia

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has received instrumental reports concerning an earthquake on December 26 from the observatories at St. Louis, Georgetown, San Juan, Tucson, Fordham, Philadelphia, Des Moines and Huancayo. From this data it appears that the earthquake originated at approximately 12h. 31·8m. U.T. from an epicentre near latitude 9·0° N., longitude 75·0° W. This is in Colombia, South America, near the confluence of the Cauca and Magdalena Rivers. Earthquakes are not uncommon in this region.

Supply of Organic Compounds

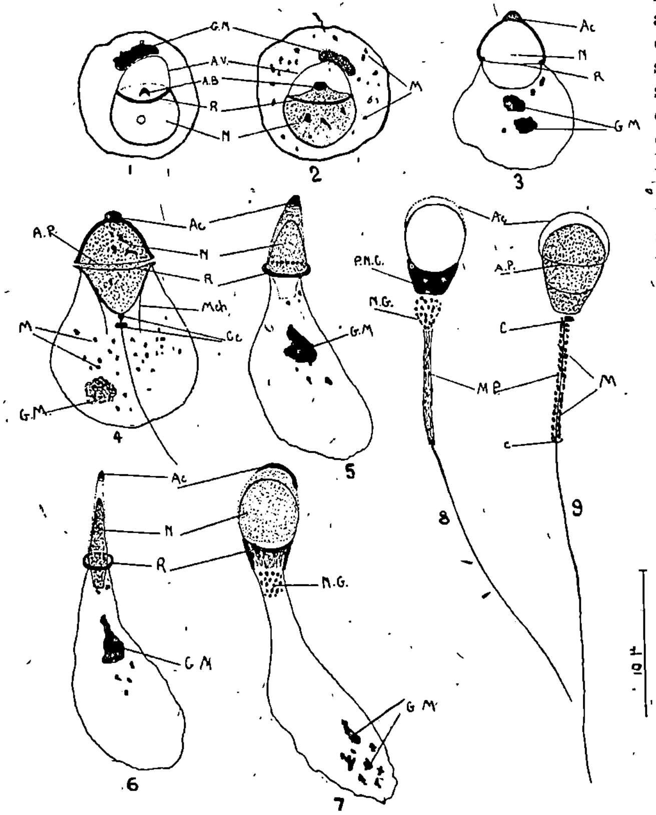
We have received from L. Light and Co., Ltd., Old Bowry Laboratories, Wraysbury, Bucks, a price list of more than four hundred organic compounds not usually available commercially. This includes a large number of compounds used in synthetic work, such as ethyl acetoacetate, ethyl malonate, and ethyl iodide, many alcohols, esters and ketones, and also inorganic reagents such as magnesium turnings, hydrazine, selenium, and selenium dioxide. It is very interesting to find that such a wide range of materials is available, and research workers should be materially assisted by having them at their disposal. A copy of the list can be obtained on application to the firm.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Nuclear Ring in the Developing Male Germ Cells of Dog and Cat

IN the course of recent work on the spermatogenesis of the dog and the cat, I noticed a peculiar ring-shaped structure on the nucleus of the spermatid and on the head of the young sperm. Observations were afterwards carried out on the origin and fate of this ring, here called the nuclear ring. Similar structures have been observed (but not so far described) in the spermatid and in the young sperm of the bull, by Dr. R. A. R. Gresson of this Department, who has shown me his preparations. As the nuclear ring has not previously been described, a short note on its appearance and development is given here. Later, I hope to publish a full account of the spermatogenesis of the dog and cat.



Ac., acrosome; *A.P.*, posterior limit of acrosome; *A.B.*, acrosome bead; *A.V.*, acrosome vacuole; *C.*, *c.*, centrosomes; *G.M.*, Golgi material; *M.*, mitochondria; *M.P.*, middle piece; *Mch.*, manchette; *N.*, nucleus; *N.G.*, neck granules; *P.N.C.*, post-nuclear cap; *R.*, nuclear ring.

Very small pieces of the testes of the dog and cat were placed immediately after death in fixing fluids and afterwards sections were cut, 5 μ and 8 μ in thickness. Smears were also made. The methods used for both sections and smears were those of Champy-Kull, Flemming, Kolatchev, Aoyama, and Regaud. The smears treated with Aoyama's method were not very satisfactory, but the sections were very clear and beautiful.

The structure and history of the nuclear ring was investigated chiefly in the dog, and the following account is of observations on that animal, although similar stages were seen in the preparations of the cat testis. The nuclear ring was first noticed as a conspicuous structure in the late spermatid, in the form of a black ring (Figs. 5, 6). The forerunner of the nuclear ring first appears in the spermatid at the stage when the acrosomic vacuole pushes up the Golgi apparatus and causes a depression on the surface of the nucleus (Figs. 1, 2). The edge of this depression, in the form of a circular line, stains more deeply than the nucleus. In the middle of the nuclear depression a small bead can be seen, the acrosome bead. At a later stage when the Golgi apparatus starts to drift down along the semilunar vacuole, the acrosome bead swells, and with the decrease in size of the vacuole the nucleus tends to regain its original shape, thus causing the disappearance of the depression. The circular line which marked the edge of the depression remains, and appears to be the forerunner of the ring-shaped structure round the nucleus of the late spermatid (Figs. 3, 5).

After the Golgi apparatus has moved away from the vacuole, the acrosome bead spreads out over the anterior part of the nucleus and forms the acrosome, the posterior edge of which rests on the nuclear ring (Figs. 3, 5, 6).

During the metamorphosis of the head of the sperm, the nucleus elongates in an anterior direction from the nuclear ring. In the unstained Aoyama's preparations the anterior part, about two thirds, of the nucleus is covered with the acrosome, which terminates posteriorly in contact with the nuclear ring. The part covered by the acrosome is of a light golden colour; the remainder of the nucleus is left unstained (Fig. 5). The detachment of the acrosome from the nuclear ring was observed in Champy-Kull preparations. Two rings are present, one consisting of the posterior limit of the acrosome, the other deeper in colour, being the nuclear ring (Figs. 4, 9).

With the metamorphosis of the spermatid, the nuclear ring becomes progressively deeper in colour in the silver preparations and in side view is very conspicuous (Fig. 5). In later stages granules are deposited along the ring, and this causes a widening of the ring in a posterior direction and a gradual blackening of the whole posterior part of the head of the nearly ripe sperm (Fig. 7). Finally, a complete cap is formed, the "post nuclear cap" of Gatenby (Fig. 8).

The presence of the post-nuclear cap in mammals was recorded by Gatenby and Wigoder[1] in the guinea pig, and in the human sperm by Gatenby and Beams[2], but no reference was made to any ring round the nucleus of the late spermatid. According to Gatenby, in the human spermatozoon the post-nuclear cap is formed by a creeping up and growth in an anterior direction of argentophil material. According to my observations on the sperm of the dog and cat, the post-nuclear cap seems to be formed by growth in a posterior direction from a fixed circular structure.

This work was carried out in the Department of Zoology, University of Edinburgh, under the supervision of Prof. James Ritchie and direction of Dr. R. A. R. Gresson.

I. ZLOTNIK.

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University of Edinburgh.

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[1] Gatenby, J. B., and Wigoder, S. B., *Proc. Roy. Soc.*, B, **104**, 471 1929)).

[2] Gatenby, J. B., and Beams, H. W., *Quart. J. Micro. Sci.*, **78**, 1 (1935).

Histochemistry of the Gram-staining Reaction for Micro-organisms

IN 1884 a Dane, Christian Gram, while working in Berlin, discovered a method of staining micro-organisms which has gone under his name ever since that date[1]. Although the method is in daily use by bacteriologists of various nationalities all over the world, and has by reason of its importance in ordinary routine diagnosis been the subject of extensive research, it may be fairly said that it has never been adequately explained.

The method consists in staining heat-fixed smears with an aqueous solution of a dye of the pararosaniline series, mordanting with aqueous iodine, washing with alcohol until no more of the blue dye can be extracted and then counterstaining with a red dye of the acid fuchsin series.

Organisms which after extraction retain the blue dye are described as being Gram-positive, while those which are decolorized by the alcoholic extraction and take up the red dye are said to be Gram-negative. Obviously there must be some marked chemical or physical differences in the two groups of micro-organisms in order to account for such diverse staining reactions. Special interest is attached to the underlying mechanisms since it has been shown[2] that dramatic differences exist in the selective bacteriostatic and bactericidal action of some of the newer anti-bacterial agents. Thus, for example, basic dyes, cationic detergents[3], penicillin, gramicidin, etc., are much more active against Gram-positive species, anionic detergents inhibit the metabolism of Gram-positive organisms only, while tellurites, azides, etc., appear to be selective against Gram-negative species.

As a result of investigations carried out conjointly, we have observed that Gram-positive organisms can be rendered Gram-negative by a variety of methods, for example, by the action of certain carbohydrate-splitting enzymes and by extraction processes. We have devised a method whereby organisms, for example, *Cl. welchii*, can be 'stripped' of an essential part of their Gram-positive material and separated into Gram-negative cytoskeletons and a Gram-negative extract. Furthermore, we have developed a simple technique whereby a fraction from the extract can be 'plated' back on to the cytoskeletons to reconstitute Gram-positive bacilli. We have been able to show that the essential constituent in Gram-positive organisms which differentiates them from those which are Gram-negative lies in their having as part of their surface structure the magnesium salt of ribonucleic acid.

The method of extracting this material utilizes the action on washed cells at 60° of a 2 per cent aqueous solution of a bile salt in presence of oxygen. Material in the extract could be precipitated by alcohol, and fractionation methods showed that it consisted essentially of magnesium ribonucleate together with inert polysaccharides and traces of proteins.

The fundamental requisite for the successful recombination of magnesium ribonucleate with the Gram-negative cytoskeleton material is that the latter must be in a *reduced* condition. A number of reducing agents have proved suitable for this preliminary reduction, but all our recent experiments have been carried out with 1 per cent formalin in 0·8 per cent sodium chloride, in which the cytoskeletons can be kept in satisfactorily receptive condition for several days. With exposure to air the cytoskeletons become irreversibly oxidized and recombination does not occur. Of particular interest is our observation that it has not yet been found possible to combine Gram-negative organisms with salts of ribonucleic acid.

In further experiments, brewer's yeast, *Saccharomyces cerevisiæ*, was subjected to the same extraction method and it was found that the extraction was essentially complete in 2–3 hours. The normal yeast cell was coated with a layer of Gram-positive material which stained a deep blue-black, and it was only when this was removed that the cytoplasm and the large nucleus it contained could be demonstrated by the Gram-staining method. The stripping of the yeast cell by the bile salt occurred in stages; as the blue-black surface material disappeared there was left a nucleated cell with a stippled surface. On further extraction the surface stippling and the nucleus were progressively bereft of their Gram-positive material so that eventually the whole cell became Gram-negative. The extract contained polysaccharides and magnesium and sodium salts of ribonucleic acid.

Magnesium ribonucleate from the extract, or from extracts of other organisms, could successively be plated back on to the reduced yeast cytoskeletons so that their nuclei became once more Gram-positive and the surface stippling also was restored. If one replaced the magnesium ribonucleate by the sodium salt this did not readily combine with the surface of yeast cytoskeletons, the results with the sodium salt being irregular and chiefly confined to plating the nuclei after prolonged contact. In no case could plating be achieved with salts of desoxyribonucleic acid or with nucleosides or nucleotides.

In the course of our experiments it has been shown that certain Gram-positive organisms, for example, *Streptococcus salivarius*, may become Gram-negative when grown in media in which the magnesium content is reduced to a minimum or in media where the production of acid is sufficient to prevent the formation of magnesium ribonucleate. In some cases these Gram-negative individuals display striking evidence of nucleation, and on sub-culture give rise on an agar surface to colonies which are *rough*, whereas their Gram-positive relatives produce colonies which are *smooth*.

The bearing of these facts on antigenic structure and relationships is under investigation, as also is the structure of the various cytoskeletons. Those from *Cl. welchii* and from *Saccharomyces cerevisiæ* give a vivid Sakaguchi reaction and appear to contain a high proportion of basic protein material. We have, therefore, some evidence for the tentative suggestion that the Gram-positive (that is, dye-retaining) material is a high-molecular complex formed by the combination of a reduced basic protein substrate with magnesium ribonucleate.

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M. STACEY.

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May 12.

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[1] Gram, *Fortschr. Med.* (I), 2, S. 185 (1884).

[2] Dubos, *J. Bact.*, 41, 269 (1941); *Biochem. Rev.*, 659 (1942).

[3] Baker, Harrison and Miller, *J. Exp. Med.*, 74, 611 (1941).

The Nature of Entropy

THE statement of Sir James Swinburne[1] that the engineer understands entropy is correct so far as heat engine cycles are concerned, because there are diagrams which give a very convenient representation of such cycles. There are, however, other energy conversion processes in engineering in which the Second Law of Thermodynamics is of equal importance and for which no comparable diagrams exist, heat transfer and combustion reactions being typical examples.

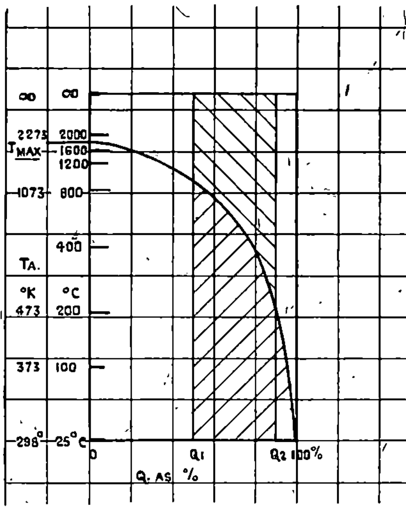

Fig. 1.

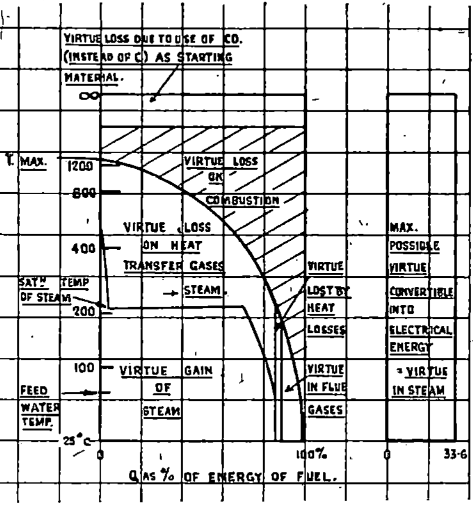
VIRTUE LOSS DUE TO USE OF CO. (INSTEAD OF C) AS STARTING MATERIAL.
∞
T. MAX.
1200
800
400
200
100
25°C
VIRTUE LOSS ON COMBUSTION
VIRTUE LOSS ON HEAT TRANSFER GASES → STEAM.
SAT^N TEMP OF STEAM
VIRTUE GAIN OF STEAM
FEED WATER TEMP.
VIRTUE LOST BY HEAT LOSSES
VIRTUE IN FLUE GASES
MAX. POSSIBLE VIRTUE CONVERTIBLE INTO ELECTRICAL ENERGY
= VIRTUE IN STEAM
0
100%
0
33·6
Q AS % OF ENERGY OF FUEL.

Fig. 2. VIRTUE DIAGRAM FOR INDUSTRIAL BOILER AND IDEAL HEAT ENGINE.

It is possible to construct simple diagrams relating to these processes which bring out very clearly the practical significance of entropy and of its negative, for which the term 'virtue' is suggested. The abscissa is Q, the 'available' heat of the working substance at a given temperature T_A (°K.) expressed in any convenient units. The ordinate is $1/T_A$. This is conveniently plotted downwards so that the line $T_A = \infty$ is at the top of the diagram and the line $T_A = 298$°K. at the bottom. Suppose now that we have a body (for example, of combustion gas) of constant specific heat at temperature T_{max}. The graph of the available heat is then a rectangular hyperbola crossing the lowest abscissa at the point representing its total heat content above room temperature and crossing the line $Q = 0$ at the point corresponding to T_{max}. (see Fig. 1). The area between the curve, the lines $Q = Q_1$ and $Q = Q_2$ and the line $T_A = \infty$ is the entropy change of the body on losing heat $Q_2 - Q_1$. It is, however, much easier to regard the area between the curve, the line $T_A = 298$°K. and $Q = Q_1$ $Q = Q_2$ as the 'virtue' of this amount of heat, since we can then express the Second Law of Thermodynamics by the statement that the virtue of a certain quantity of heat must always decrease in any physical process.

It is at once possible to represent heat transfer by drawing the curves for the body losing and the body receiving heat with corresponding values of Q. The area between the curves is then the irreversibility of the process or the loss of virtue of the heat.

Heat engine processes may also be conveniently represented, since the condition for the perfect engine that entropy does not increase is represented by an equal area under the curve for the working fluid, and that for the mechanical or electrical energy, which are lines coinciding with $T_A = \infty$.

When considering a chemical reaction such as combustion, it is necessary to take into account the fact that there is an entropy change between the initial and final compounds when both are at room temperature. If this is done by representing the initial virtue of various fuels by lines differing slightly from $T_A = \infty$ (the correction is of importance only in the case of carbon monoxide and hydrogen) then the irreversibility of adiabatic combustion is the area between this initial virtue and the curve for the 'theoretical' hot products of combustion.

It thus becomes possible to represent on one diagram the irreversibility of the successive stages of (1) combustion of a fuel, (2) heat transfer from the hot gases to steam, and (3) conversion of the steam energy into mechanical work. An industrial example is shown in Fig. 2.

These ideas have considerable practical importance in these times when energy conservation is so vital to the war effort.

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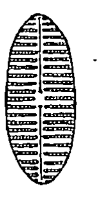
[1] NATURE, 151, 335 (1943).

A Diatom New to Britain

IN a previous communication[1] one of us described the insect fauna of a brine-pit[2] situated on the border of Cheshire and Flintshire about two miles south of Malpas. The diatom flora of this same pit has recently been the subject of an investigation by us. Preliminary observations indicate that the majority of the diatoms occurring in the pit are exceedingly minute and that their frustules are poorly silicified. Generally speaking, the assemblage of forms is of the type to be expected in a brackish habitat. A complete account of the diatoms found must await later publication. One diatom, however, which we have identified as *Navicula incerta* Grun. (see accompanying illustration), is of special interest and deserves notice now because it is a purely marine form and so far as can be ascertained from the sources of information at our disposal[3,4,5,6] has not previously been recorded from British waters.



(× 1450).

Navicula incerta was found in a gathering collected from the brine-pit on June 21, 1942. An analysis of the pit water at that time showed the following composition: 9,500 parts of sodium chloride per 100,000; 10,400 parts of dissolved solids per 100,000, and a pH value of 7·5 (Lovibond comparator).

Navicula incerta was by no means a common diatom in the gathering; in the six strewn slides examined only seven specimens were observed. These varied somewhat in length from 0·014 mm. to 0·019 mm., but they were all 0·006 mm. in breadth. In each of the forms examined the number of striæ was uniform at 16 in 0·010 mm., and the lineolations 15–17 in 0·010 mm.

P. T. Cleve[7] describes this diatom as follows: "Navicula incerta (Grun 1880) linear with slightly convex margins and obtuse ends. Length ·016 mm., breadth ·006 mm., striæ 15 in ·010 mm. not radiate; axial and central areas indistinct. NOTE. A small form with coarse striæ unknown to the author—Marine".

We are appreciative of the kindness of the Director of the Royal Botanic Gardens, Kew, for supplying a number of the references quoted.

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[1] Burke, F., NATURE, 150, 610 (1942).

[2] Sherlock, *Mem. Geol. Survey*, "Mineral Resources of Great Britain, Rocksalt and Brine", 18, 54 (1921).

[3] Kew. No Herbarium record.

[4] *Biological Abstracts* back to 1927.

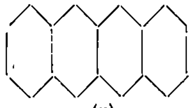
[5] Tilden's "Index Algarum Universalis".

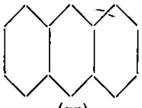
[6] Index to the articles on, and the references to, Diatomaceæ in the *Transactions* and *Journal of the Roy. Micro. Soc.*, Lond. (1853–1915).

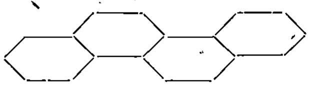
[7] Cleve, P. T., "Synopsis of the Naviculoid Diatoms", Part 2, p. 26.

Fluorescence of Anthracene in Presence of Naphthacene

IT is known that pure naphthacene crystal (I) luoresces very feebly, but in dilute solid solution of anthracene (II), the crystal fluoresces with its characteristic yellow-green light; and the blue fluorescence of anthracene is quenched.


(I)


(II)


(III)

This phenomenon is represented as follows: in dilute solid solution the anthracene molecules easily absorb light energy and release an 'exciton' which causes naphthacene to fluoresce. We find that solid naphthacene fluoresces not only in anthracene, but also in chrysene (III); there is a little shifting of the fluorescence bands, depending on the substance with which it is mixed.

In view of this fact, the study of fluorescence spectra in alcoholic solution of anthracene, naphthaene and the mixture of the above two is interesting. n alcoholic solution, anthracene has four fluorescence bands (excited by 3,650, 4,046 of the mercury arc), and naphthacene has three fluorescence bands on the ed side of the fluorescence bands of anthracene; the mixture has both the fluorescence of anthracene and of naphthacene. Three solutions were prepared, one of pure anthracene, the other of pure naphthacene, and the third a mixture of the two. The number of gram molecules per c.c. of anthracene and of naphthacene in the mixture were identical with those of the pure substances taken separately. Exposures were given for the same time and under identical conditions.

It was found that there is no appreciable change of intensity of the fluorescence bands of anthracene due to the presence of naphthacene; or of that of the fluorescence bands of naphthacene due to the presence of anthracene. Absorption spectra of the above three solutions confirm the result.

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March 26.

Post-War Agricultural Education

IN the last paragraph of the second column on p. 540 of the article on post-war agricultural education published in NATURE of May 15, quotations from the Report of the Luxmoore Committee dealing with courses in agriculture and horticulture are summarized as follows: "It is difficult to understand that what is right for horticultural graduates is wrong for agriculture". It is not clear from the text of the article on what grounds this charge of inconsistency is made. Two constructions are possible, both of which rest on a misunderstanding of the Committee's intentions.

If the objection is to the establishment in universities of graduate courses leading to diplomas in horticulture, it is without foundation because there is a similar recommendation in the case of agriculture. Further, the proposed diploma courses in both subjects would be of an advanced nature for those already possessing a degree, and would be given in a university.

On the other hand, it may be that the objection refers to the statement that instruction in horticulture should be given in a "separate department". The fact that some agricultural colleges are now departments of a university may have given rise to the assumption of a difference in treatment of the two subjects. The idea of a separate department for horticulture reflects the Committee's view that horticultural education requires separate and different treatment and should not be considered as subservient to agriculture. The departments proposed were intended to be an integral part of the university concerned, and not physically isolated as in the case of the agricultural colleges. It was envisaged by the Committee that the teaching of agriculture and horticulture in a university should be on the same lines, namely, in separately constituted university departments. Thus the statement quoted that for agriculture "the whole of any course leading to a degree should be taken in the University itself so that the benefit of contact with teachers and students engaged in other subjects should not be lost" applies with equal force to the teaching for degrees in horticulture.

RONALD EDE
(Secretary of the
Luxmoore Committee).

School of Agriculture,
Cambridge.

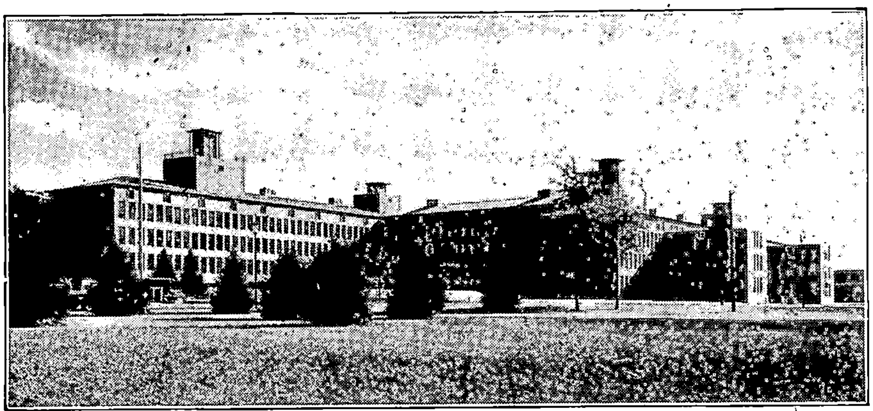
MURRAY HILL LABORATORY OF BELL TELEPHONE LABORATORIES

By FRANKLIN L. HUNT

Bell Telephone Laboratories

A RURAL location for part of the research and development work of Bell Telephone Laboratories has long been contemplated, and after extensive preparations it has taken form at Murray Hill, New Jersey, about twenty-five miles from New York City. In a group of new buildings there, on a 200-acre site bordering a park reservation, are now accommodated about eight hundred of the Laboratories' employees, which now number more than six thousand.

The buildings form an H-shaped structure of buff-coloured brick which provides approximately 215,000 sq. ft. of laboratory area. There is also a separate acoustics building, a boiler house and a garage. The main building is in two parallel sections, 675 ft. and 340 ft. long. These are connected by a 144-ft. transverse building in which the entrance is located. There are also five 50-ft. projecting wings on the two parallel buildings to provide additional space for the offices. Each section of the building has three laboratory and office floors, a cellar and an attic. The latter are used exclusively for piping, pumps, ventilating systems and storage.



Murray Hill Laboratory of Bell Telephone Laboratories. *Photograph by Eric Baker.*

Restaurant, cafeteria and luncheon room facilities, with a combined seating capacity of more than four hundred persons, and a kitchen completely furnished with the most up-to-date equipment have been provided. These are essential to the operation of the plant because other eating places are not available in the immediate vicinity.

In designing the Murray Hill building, plans were made not only to provide laboratory and office space of any size needed, but also to make quick changes and re-arrangements possible. There are no permanent partitions in the buildings except those around the stair wells, toilets and elevator shafts. All other partitions are built up of standard metal panels 10 ft. 8 in. high and, with a few exceptions, 4 ft. wide. The outside surfaces of these units are sheet steel, which is stiffened by transverse members welded to it inside on 9-in. centres. The steel sides are separated by a 3-in. space which is packed with rock wool to prevent the transmission of sound and heat. The inside surface of the steel is also coated with a deadening material. Doors and transoms are made in one unit which is 4 ft. wide so that it can be interchanged with a partition in any part of the buildings.

Along the outside wall of the buildings there is sheet steel wainscoting under the windows and up the piers between them. This is the same in appearance as the partition panels and it is also stiffened like them with transverse members and coated on the back side with mastic. This wainscoting is removable without special tools to give access to service pipes and wiring behind it. Similar wainscoting is applied around interior columns.

A research laboratory requires many special facilities such as compressed air, vacuum, hydrogen, oxygen, nitrogen and illuminating gas, steam at several pressures, hot, cold, chilled and distilled water, chemical drains, and electric power at different voltages. Fifteen such services are regularly supplied and distributed to individual laboratories at Murray Hill, and there are also special services. The service mains are installed either in the basement or the attic. Risers are grouped at the outside walls and pass up through vertical chases located there at 6-ft. intervals throughout the buildings. Horizontal run-outs below the window-sills pass behind the metal wainscoting and extend all the services into individual laboratories. To get these services from the risers at the side walls to laboratory benches, special supports were devised for quick attachment to the partitions.

Another method of bringing service pipes into the laboratories is through ducts in the floor fill which extend 8 ft. into the room from the outer wall. These ducts are installed only when required for 'island' benches located in the centre of the room and are used principally in the chemical laboratories. They have steel covers with open sections where the services turn up at the benches. In the laboratory rooms, electric power is distributed along each wall in a metal trough with removable cover plates which face out so that wiring can be readily changed. These plates are interchangeable and may be either plain or equipped with outlet and protective devices.

Forced ventilation is provided for the chemical laboratories by blower units which take in fresh air, filter and temper it and force it through ducts into each laboratory room. The air is exhausted through the fume hoods by another set of fans. All the ventilating equipment is located in the attic of the chemistry section of the buildings.

An unusual feature at Murray Hill is the distribution of hydrogen, oxygen and nitrogen as well as illuminating gas to individual laboratories by pipes from a central supply. The hydrogen is stored in pressure tanks in one room and the oxygen and nitrogen in another to avoid fire hazard. There is a rate of flow gauge in the hydrogen lines to keep the amount used in any room below that which could form an explosive mixture. All these gases are distributed from the attic to individual laboratories by mains which run the length of the building under the roof.

The acoustic laboratories are housed in a separate building to avoid noise and vibration from other activities. Besides regular laboratory space, this includes a large 'dead' room for response measurements of microphones and loud speakers, two 'live' rooms or reverberation chambers for transmission and absorption measurements and a small auditorium.

The auditorium was built primarily for experiments in auditorium acoustics and its construction follows the latest practice in acoustic treatment. To break up reflections, the side walls are splayed and the rear wall is sloped away from the seats for the same purpose. Panelling at the rear of the room, and that on the adjacent side walls and ceiling, is perforated and backed by absorbing material to reduce reflected sound from these areas. There are 363 seats. Each is upholstered to absorb about as much sound when not occupied as would a person, thus maintaining the same reverberation characteristics in the room whether it is empty or filled to capacity. For the convenience of the audience, the seats are widely separated in accord with European practice. Although made quite reverberant for musical reproduction, the excellent acoustic characteristics of the listening room make it exceptionally satisfactory for speaking. There are no windows. Decorative lights are mounted on the side walls. Recessed lamps are distributed uniformly over the ceiling and spotlights illuminate the platform and speaker. These groups of lights can be used separately or in combination and most of them can also be dimmed.

A technical library is an indispensable adjunct to a research laboratory, and provision has been made at Murray Hill for this need by transferring about eight thousand volumes from the main library at New York City. Reference books and technical periodicals make up most of the collection, since other books are always available on request from New York. The stacks are made of sheet steel with adjustable metal shelves, slotted to prevent the accumulation of dust, and the front edge of the lowest wo shelves is tilted upward to aid in reading titles. Along two sides of the room there is a row of small tudy carrells with chair, writing-table and shelves or the convenience of those who have long assignments and who wish to have several reference books mmediately at hand. This is a valuable feature, ecause it provides privacy and avoids the confusion nd disturbance of a common study table.

The additional facilities provided at the Murray Hill Laboratories are in great demand in the present war emergency, and are contributing effectively toward the solution of many problems posed by the onflict. Practically the entire staff is now engaged n war work.

A MYRMECOPHILOUS WOODLOUSE

IN the spring of 1938 Prof. G. E. Hutchinson found a small white blind myrmecophilous sowbug in North Branford, Connecticut. The species was afterwards found in ants' nests in a small tract of country several miles in area round about the original locality, nd within the Mt. Carmel region of Hamden, Conn., some nine miles from North Branford.

Prof. J. L. Brooks, in a recent paper (*Ecology*, **23**, No. 4, 427–37; 1942), points out that in 1921 there were five valid species of Platyarthrus, four of these being restricted to the Mediterranean region, and only one, *P. hoffmanseggi* Brdt., being found throughout Europe. In 1931 Archangeli described a new species from the Canary Islands, and in 1934 Demianowicz reported two more from Bessarabia. The Connecticut species was identified as *Platyarthrus hoffmanseggi* Brdt. Its distribution is given as Upper Italy, Spain, France, Switzerland, Holland, Germany, Denmark, Austria, Hungary, Russia and the British Isles.

North Branford, Conn., is the first place in the New World where a Platyarthrus has been found. In all probability it was accidentally introduced from Europe.

All the species of this genus are myrmecophilous, but most of the observations concerning them are confined to the species in question. Although Wasmann considered *P. hoffmanseggi* to be pan-myrmecophilous, Prof. Brooks says that it has not been recorded with other ants than those he lists. He points out that the records from the Continent are from Archangeli; and for England from Donisthorpe, and Webb and Sillem. He is indebted to Prof. Neal A. Weber for the names of the ants with which it has been found in America.

Prof. Brooks considers that the data indicate the existence of some factor or factors governing the presence of this sowbug only in the nests of certain species in any region. This is possibly the case; but I am inclined to think that if collectors had always recorded the presence of the crustacean when they had seen it, or had specially looked for it, the number both of localities and species of ants would be considerably greater.

As Mr. Brooks is not a myrmecologist himself, he can be excused for some errors in his list of ants. There are no species called *Myrmica rufa*, or *Formica flava*. Also the genus *Atta* F. only occurs in Texas, Mexico, Central and South America, and has certainly never been recorded from Europe. *Atta cephalotes* L., not *cephalotis*, is recorded from the basin of the Amazon, Columbia, Central America, and Mexico. Furthermore, as Prof. Brooks says himself, he has used the generic nomenclature adopted by the Committee of the Royal Entomological Society of London, and thus has been 'let down' about *Acanthomyops*. For example, *A. fuliginosus* Latr. belongs to the subgenus *Dendrolasius* Ruzsky. It could be called, according to whether one accepts Lasius or Acanthomyops as the genus, either *Lasius* (*Dendrolasius*) *fuliginosus* Latr., or *Acanthomyops* (*Dendrolasius*) *fuliginosus* Latr., but never *Lasius* (*Acanthomyops*), (see Donisthorpe, *Ent. Record*, **49**, 143; 1937). Also *flavus* F., and *umbratus* Nyl., belong to the subgenus *Chtonolasius* Ruzsky. The variety of *Formica fusca* L. is *glebaria* Nyl., not *gleboris*.

We now come to Prof. Brooks' experimental work to endeavour to discover the factors involved in the relationship between the woodlouse and its hosts. These are of a delicate, ingenious, and painstaking nature. They are intended to test the response to light (phototaxis), unoriented response (photoklinokinesis), response to atmospheric humidity gradient, and the reaction to a gradient of formic acid vapour, and are illustrated by diagrams, graphs, histograms, etc. The results are briefly as follows. *Platyarthrus hoffmanseggi* showed no direct response to light under the conditions used in the experiments. It showed a lower klinokinesis in the light than in the dark, and the klinokinesis of this species was found to be much greater than that of the non-myrmecophilous woodlouse *Oniscus asellus*. It moved towards the humidity end of a humidity gradient, as does also *Oniscus asellus*. It is attracted towards formic acid vapour, whereas *Oniscus asellus* avoided it. It was indifferent to acetic acid vapour, but that of propionic acid repulsed it.

In my observation nests I found that *Platyarthrus hoffmanseggi* always sought the dark chambers of the nest, but this is probably because they are the dampest, and also they are those usually inhabited by the ants themselves.

Prof. Brooks considers that the evidence strongly supports the supposition that Platyarthrus is chiefly found in the nests of those ants which possess an appreciable amount of formic acid. He says that the question of the food of this species has never been adequately answered. He quotes what I wrote on this subject: "Lord Avebury suggested that it fed on spores of the lower plants, such as would be found in ants' nests. These, however, would not be present in plaster nests, and I believe that the food of this species also, in part at least, consists of the 'boulettes de nettoyage' from the ant's infrabuccal cavity"*; but he points out that Platyarthus has been kept in the laboratory for months away from ants, and has even reproduced itself. He thinks it is obvious that these creatures are not directly dependent on ants, but that the nests of the latter provide an environment in which they have a better chance of surviving.

A useful list of references is given at the end of the paper, which is a very able contribution towards the life-history of the animal in question. The discovery that it is attracted by the vapour of formic acid is of considerable value.

HORACE DONISTHORPE.

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* "Guests of British Ants", 215–17 (1927).

ELECTROMETALLURGICAL INDUSTRY

DR. J. W. CUTHBERTSON, of the University of Manchester, gave a lecture on May 19 before the London and South Eastern Counties Section of the Royal Institute of Chemistry on "Recent Advances in Electrometallurgical Industry". He pointed out that during recent years, and especially since the outbreak of war, development in this field has been very rapid, particularly in the United States, where raw materials are plentiful and there are ample facilities for the production of cheap electrical energy. The possibilities of further expansion both in Great Britain and elsewhere, however, are now being exploited, and the development of the home industry will doubtless be stimulated by the growing realization that, in certain circumstances, electrical energy can be produced by the modern steam generation station on a basis which compares favourably with the cost of production by a hydro-electric plant.

Electrometallurgy can be subdivided into two main sections covering electrolytic processes and electrothermal processes respectively. The former include extraction, refining, electrodeposition, surface protection and so on. In the extraction field, mention may be made of the enormous expansion in the production of aluminium and magnesium, and of the pioneer work now yielding results in the Unite States on the electrolytic production of manganes from low-grade ores.

Turning to the sphere of electrodeposition, brigh plating, which was first introduced some years ago has since made great strides. This is particular noticeable in the case of nickel and latterly also o zinc. Electrogalvanizing has now to a large exten superseded the old hot-dip process, while considerabl progress is being made in the corresponding electro tinning industry. Hard chromium plate is in wid demand throughout the engineering industry as means of obtaining improved resistance to surfac wear and abrasion of metals and alloys. Effort which continue to be made to find a non-toxic substitute for plating baths of the cyanide type appea to be meeting with some success, more especially a regards the deposition of copper. Recent work o the deposition of aluminium from non-aqueou electrolytes has led to the development of a proces which is now being exploited on a semi-industri scale. Considerable advances have also been recorde in the deposition of alloys—a field which for certai engineering and other applications would appear t offer possibilities.

Until only a very few years ago, electrolytic polishing was almost unknown outside the laboratory, bu rapid progress has been made recently in the industrial development of this method of surface finishin

In the electrothermal field the most noteworth achievement of recent years has probably been th perfecting of the coreless induction furnace; originall these furnaces were used mainly for melting an alloying, but promising results have also bee obtained by using them in refining practice. Th use of the coreless furnace as a means of raising th temperature of metals and alloys for purposes heat treatment is increasing; the versatility of th method is well illustrated by its application to th internal hardening of hollow parts. In the resistan furnace field, developments have largely been confined to improvements in the design and control units of the closed type intended to be used wit special gas atmospheres. Arc furnaces have undergon marked changes in design, but apart from the growin demand for electric steel and consequent expansio of plant, there has not been a great deal of chang in arc furnace practice during recent years.

THE JOHN INNES HORTICULTURAL INSTITUTION

A USEFUL review of some recent work horticultural science is provided by th annual report for 1942 of the John Innes Hort cultural Institution (from the Institution, Mosty Road, Merton Park, S.W.19, March 1943). M M. B. Crane and his colleagues in the Departme of Pomology have investigated various factors whic affect the production of fruit and seed crops. Dr. Lewis finds, for example, that the English cucumb produces seedless fruits when grown at a high te perature, even after the flower has been adequate pollinated. At low temperatures the fruits may seeded or seedless, according to whether the flowe have been pollinated or not. Mr. A. G. Brown h related the phenology of apple and pear trees to t suitability of varieties for cross pollination. Some varieties of pear which did not overlap their blossoming times in 'long flowering period years' (1939 and 1941) did so in years with short flowering periods (1940 and 1942). The approximate flowering times of 320 varieties of apple and 138 varieties of pear have been listed.

Alpha-naphthalene acetamide has been used by Dr. Lewis to prevent 'June-drop' in cherries, plums and pears. This substance is applied in aqueous solution or in lanolin to the styles and flower stalks. It delays abscission of the style for two days, thereby giving greater possibility of pollination, and therefore increased fertility.

Dr. K. Mather and his staff in the Department of Genetics have studied the question of polygenes, which are now found to form balanced combinations within the chromosomes under the action of natural selection. Several new lines of approach are thereby opened to problems raised by the behaviour of wild and cultivated plants.

An interesting result from the Department of Cytology is the production of tetraploids by the use of colchicine in species of Nicotiana and related genera.

The Garden Department, under Mr. W. J. C. Lawrence, maintains an extensive advisory service, and has carried out experimental work on the war-time use of fertilizers.

The report of the director, Dr. C. D. Darlington, announces the help of the Agricultural Research Council in the prosecution of new work on the conditions of breeding and maintenance of cultivated varieties of plants. Many other results of the Institution's work are recorded briefly in the report.

PROBLEMS OF AMERICAN UNITY

TWO remarkable pamphlets, bearing the titles "National Unity through Intercultural Education" and "What Democracy Means in the Elementary School", have been published by the U.S. Office of Education at Washington. They belong to a projected series* of about twenty, some of the other titles being "Our Country's Call to Service", "What the Schools Can Do?" and "Hemisphere Solidarity". The whole series bears the title "Education and National Defense". Everyone agrees, says the U.S. Commissioner of Education, that "the schools must become increasingly vital centres for the education of youth and adults facing a war-torn world. But how ?" That is the question which this series is meant to answer.

The answer cannot be so easy for the United States as it is for Great Britain. We all know well enough for practical purposes what is meant by being an Englishman, but here we have a representative American seriously raising the question—"What is an American ? Who is he ? Is he of Anglo-Saxon background, which group makes up half the American population ? Or does he represent the 15–20 millions of German background, the 5 millions of Italian, the 4 millions of Scandinavian, the 2 millions of French, or the 8–10 millions of various Slavic backgrounds ?" We are all familiar with the metaphor of the melting-pot, but it is hard for the untravelled Englishman to realize the immensity of this melting process, and to grasp at once the inner significance of this series of broadcast pamphlets. It is the latest manifestation of the fact that an essential part of the melting process is the system of education. America's lavish support of her schools and universities is due not only to her democratic desire to banish ignorance, but also to her desire to take the quickest and surest road towards national unity.

The pamphlets, which are beautifully produced and abundantly illustrated, contain specific suggestions for the adaptation of the established curriculum to new needs, and they present materials suitable for various educational levels from the primary school upwards. Every care is being taken to secure help and sympathy from teachers and officials in all parts of the United States, to ensure the success of the enterprise.

One reflexion should ever be in the mind of the Englishman as he contemplates the great American war effort. American history, of which he is not quite so ignorant as he used to be, is the history of a gradual union of what were originally a number of independent States, and she can no more get away from the strong tradition of "States rights" than a man can walk away from his own shadow. In many respects the strength of the States, and the corresponding weakness of the central government, has been, and remains, a great advantage. But it is beginning to be realized that America must face her enemies, not as forty-eight States, but as a united nation. This series of pamphlets, issued by the U.S. Office of Education at Washington, and appealing to the whole of America, is perhaps something more than a straw indicating the direction of the wind.

T. RAYMONT.

POST-WAR PLANNING OF PSYCHOLOGY IN THE UNITED STATES

THE National Research Council of the United States, the Government-endowed body which promotes research in America, has a division devoted to research in anthropology and psychology. Soon after the outbreak of the present War this division established an Emergency Committee in Psychology on which representatives of the American Psychological Association and other psychological societies were asked to serve. In May 1942, the American Emergency Committee formally recognized long-range planning for the advancement of the profession of psychology as one of its fundamental problems. A group of six psychologists was appointed to prepare a report for the Committee on the immediate and post-war measures that appeared desirable for the promotion of psychology as a profession.

This Committee has considered how the psychological profession might be unified and urges the formation of a single national centre to be known as the American Institute of Psychology*. This central national institute would serve as a 'professional union' of psychologists corresponding to the British Medical Association, which unifies the medical profession. Secondly, this institute should aim at integrating the desirable educational facilities of the graduate organizations and of clinic experience whether in school, hospital or factory, and whether as 'pure' or as 'applied' psychologists, should work in co-operation with their fellows in other branches of inquiry and practice. Finally, it is suggested that psychological practice should be organized as public service.

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* Education and National Defense Series (Federal Security Agency, U.S. Office of Education, each 15 cents).

* Post-War Planning for Psychology, *Occupational Psychology*, 17, No. 2 (April 1943).

In Great Britain there is no single body representing America's National Research Council with its various divisions. Instead, there is the Medical Research Council, the Department of Scientific and Industrial Research, and the Agricultural Research Council. The British Psychological Society corresponds to the American Psychological Association. We think, however, that there should be less difficulty in organizing the professional interests of national psychological societies in Great Britain because there are fewer. Like the Royal Society of Medicine, the British Psychological Society unites all branches of the subject. The creation of a central institute, offering a single service for the promotion of psychology as a profession, is worthy of serious consideration. The societies should be left to continue their scientific work, but they cannot promote and protect psychology as a recognized profession as effectively as a common 'union'.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, June 15

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. V. Gordon Childe: "Directional Changes in Funerary Practices during 50,000 Years".

Thursday, June 17

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—The Rt. Hon. Lord Hailey: "Capital and Colonies".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. E. H. Neville: "Jacobian Elliptic Functions".

Chadwick Public Lecture (at the Chelsea Physic Garden, Swan Walk, Chelsea, London, S.W.3), at 4 p.m.—Mr. F. J. Chittenden: "Plants Causing Irritation".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. R. V. Southwell, F.R.S.: "Relaxation Methods—A Mathematics for Engineering Sciences" (Bakerian Lecture).

Friday, June 18

Institution of Mechanical Engineers (Applied Mechanics Group Meeting) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. Hugh O'Neill: "The Significance of Tensile and other Mechanical Test Properties of Metals".

Saturday, June 19

Institute of Physics (Joint Meeting of the Electronics Group and the Manchester and District Branch) (in the Physics Department, The University, Oxford Road, Manchester), at 2.30 p.m.—"The Electrical Discharge in Gases" (Dr. T. E. Allibone will speak on "Discharge Phenomena" and Dr. J. M. Meek on "Modern Theories of the Discharge").

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Mechanical Engineering—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Chelmsford (June 17).

Lecturers (2) in Mechanical Engineering, and a Lecturer in Building Subjects in the Constantine Technical College and Technical School for Boys—The Director of Education, Education Offices, Middlesbrough (June 18).

Laboratory Assistant to the Advisory Dairy Bacteriologist—The Secretary, Department of Agriculture, The University, Leeds (June 18).

Assistant Speech Therapist—The Director of Education, Education Offices, Nelson Square, Bolton, Lancs. (June 19).

Assistant Lecturer in Building—The Registrar, College of Technology, Manchester 1 (June 21).

Speech Therapist—The Medical Officer of Health, Town Hall, Shipley, Yorks. (June 21).

Lecturers (2) in Mathematics—The Principal, Derby Technical College, Normanton Road, Derby (June 21).

Psychiatric Social Worker to work with the Psychiatrist and Educational Psychologist in the Child Guidance Clinic—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (June 21).

Lecturer in Education, preferably a woman well qualified in Psychology—The Warden, Goldsmiths' College, at University College, Nottingham (June 26).

Head of the Mining Department, and an Assistant Lecturer in Mining—The Principal, Cumberland Technical College, Workington (June 26).

City Bacteriologist—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (June 30).

Professor and Head of the Department of Electrical Technology, and a Professor and Head of the Department of Applied Mechanics and Automobile Engineering—The Registrar, Indian Institute of Science, Bangalore, India (September 15).

Assistant in the Department of Physiology—The Secretary, The University, Aberdeen.

Inspector of Mines in the Gold Coast under the Government of that Territory—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1717), Alexandra House, Kingsway, London, W.C.2.

Psychiatric Social Worker—The Medical Superintendent, Springfield Mental Hospital, Tooting, London, S.W.17.

Lecturer in Mechanical Engineering, and a Lecturer in Electrical Engineering—The Clerk to the Governors, Technical College, Chesterfield.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Substitute Materials in War and Peace. By Cecil H. Desch. Pp. 28. (London: Royal Institute of International Affairs.) 9*d.* net. [115

Report of the British Commonwealth Science Committee. Pp. 12. (London: Royal Society.) [115

Some Notes on Water Treatment. By Russell G. Pelly. (Twenty-fifth Streatfeild Memorial Lecture.) Pp. 24+2 plates. (London: Institute of Chemistry.) [115

Education and the United Nations. Report of a Joint Commission of the London International Assembly and Council for Education in World Citizenship. Pp. 54. (London: Council for Education in World Citizenship.) 1*s.* net. [115

Health—What needs to be Done. Report of the London Conference of Health held at the Conway Hall, 21st February 1943. Pp. 20. (*London: Mrs. N. C. Wolfe, 30 Sinclair Mansions, W.12.*) 6*d.* [115

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 61, Part 4, No. 29: The Effects of Radiation on Pollen Grain Development, Differentiation and Germination. By Dr. P. C. Koller. Pp. 398–429+1 plate. (Edinburgh and London: Oliver and Boyd.) 3*s.* [115

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 3, No. 23: On Problem connected with Item Selection and Test Construction. By D. N Lawley. Pp. 273–287. 1*s.* 3*d.* Vol. 61, Part 3, No. 24: On the Equation of Motion of a Free Particle in the Expanding Universe of Kinematical Relativity. By E. A. Milne. Pp. 288–297. 1*s.* Vol. 61, Part 3, No. 25: Axiomatic Treatment of Kinematical Relativity; a Repl to Dr. G. C. McVittie. By Dr. G. J. Whitrow. Pp. 298–299. 6*d* Vol. 61, Part 3, No. 26: The Monomial Expansion of Determinants Symmetric Functions. By Dr. A. C. Aitken. Pp. 300–310. 1*s.* (Edinburgh and London: Oliver and Boyd.) [11

Other Countries

Proceedings of the United States National Museum. Vol. 93, No 3157: The Nearctic Species of Parasitic Flies belonging to Zenilli and Allied Genera. By Wendell F. Sellers. Pp. 108. (Washington D.C.: Government Printing Office.) [21

Fifty-ninth Annual Report of the Bureau of American Ethnolog to the Secretary of the Smithsonian Institution, 1941–1942. Pp. 1 (Washington, D.C.: Government Printing Office.) [11

U.S. Department of Agriculture. Miscellaneous Publication No 500: The Fleas of North America; Classification, Identification an Geographic Distribution of these Injurious and Disease-Spreadin Insects. By H. E. Ewing and Irving Fox. Pp. 143. (Washington, D.C. Government Printing Office.) 20 cents. [11

U.S. Office of Education: Federal Security Agency. Bulletin 1942 No. 5: Our Neighbor Republics; a Selected List of Readable Book for Young People. Prepared by Nora E. Beust, assisted by Eimil Sandsten Lassalle and Jean Gardiner Smith. Pp. vi+50. (Washington, D.C.: Government Printing Office.) 15 cents. [11

Transactions of the American Philosophical Society. New Serie Vol. 33, Part 1: *Diary of a Journey through the Carolinas, Georgi and Florida, from July 1, 1765, to April 10, 1766.* By John Bartram Annotated by Francis Harper. Pp. iv+120+22 plates. (Philadelphia American Philosophical Society.) 2 dollars. [11

Publications of the Observatory of the University of Michiga Vol. 8, No. 12: On the Spectra of Novae. By Dean B. McLaughli Pp. 149–194. (Ann Arbor, Mich.: University of Michigan Press.) [11

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ASPECTS OF INTERNATIONAL COLLABORATION

IN an important passage in his broadcast some weeks ago, the Prime Minister expressed the hope that we would not lightly cast aside all the immense work which was accomplished by the League of Nations, and said that we must take as our foundation in restoring the true greatness of Europe the lofty conception of freedom, law and morality which was the spirit of the League. In this he was following up remarks by Mr. Eden and Mr. Herbert Morrison, who in earlier speeches had urged the necessity of making full use of existing machinery for international co-operation, both that established to further the war effort, such as the Combined Raw Materials Board, and those institutions such as the League of Nations and the International Labour Organisation, which had already proved their worth in certain technical and non-political fields before the War. The importance of collaboration between various nations is emphasized further by the draft plan just issued by the Government of the United States, after discussions with the Governments of Great Britain, the Dominions, the U.S.S.R. and China, for the organization of a United Nations Relief and Rehabilitation Administration, for the delivery of food, clothing, and medical supplies to the peoples of Axis-occupied countries as they are liberated.

In an article in *Agenda* of February, Sir John Fischer Williams discusses a reconstruction of the League of Nations. Sir John is clearly right in stressing the value of the successful treatment of questions of international trade and general economics, disarmament, emigration, intellectual co-operation, public health, the development of international legislation, the protection of minorities, and the system of mandates, in creating better psychological conditions as the foundation of the international society of the future. The proposals he advances are inspired by four main ideas suggested by the experience of the past twenty-five years. First, the League should be made not an organization for the suppression of war by war, but a force making for the recognition—to use the language of Christianity or of Stoic philosophy—of the brotherhood of man and the fatherhood of God. Secondly, military measures to suppress the crime of aggressive war should be left to the action of States grouped in freely concluded alliances and federal organizations; all special measures against the Axis Powers would thus form part of the peace treaties which will end the present War and would not be the business of the League. Thirdly, the causes of international differences should be dealt with by peaceable discussion before they become critical; and fourthly, action should be limited to what is possible at the present stage of human development.

Much that Sir John Williams proposes is common ground with other writers in this field. Some of his main ideas were also urged in the broadsheet on "European Order and World Order" issued by Political and Economic Planning in November 1939.

His view that the question of League reform requires long and expert consideration and should not be undertaken until the passions aroused by the War have had time to cool is not likely to be seriously challenged. Furthermore, the Government is clearly committed in the speeches to which we have already referred to making full use of the institutions or organizations already available, and the first report of the Combined Raw Materials Board also looks forward to constructive work after the War.

The most significant move in this field is undoubtedly Mr. Eden's recent visit to the United States. Mr. Wallace's blunt assertion that unless the Western democracies and the U.S.S.R. come to a satisfactory understanding before the War ends another world war is inevitable, is a reminder that the principal condition of a lasting peace is an adequate political system within the framework of which co-ordinated economic and social policies can thrive. The essential task of organizing military and economic power for the fulfilment of common purposes and for the benefit of all cannot be entirely postponed until the final peace settlement and the determination of some permanent organization of world order. It is a condition of the re-establishment of order itself, of facilitating passage from war and chaos to order; and it is imperative that due thought should now be given to the conditions, the ways and means upon which the essential Anglo-American and Russian co-operation can be achieved.

The future peace will most assuredly depend largely upon what is done and what is left undone during the War. The essential means of political and economic co-operation will be developed most naturally out of the organizations, already in action or being established, to control and direct the common effort in war and in the immediate work of relief and rehabilitation in the occupied countries as they are liberated. Planning cannot well go beyond this point, but the experience of the organizations already in being, like those discussions in which Mr. Eden has been concerned on the needs of peace as well as those of the War, have a further contribution to offer in fostering the mutual confidence and tolerance which are as essential in peace as in war.

Independently of Mr. Eden's visit, American opinion was increasingly recognizing the necessity of effective and continuous international co-operation, military, political and economic, not only to win the War but also to safeguard the peace after the War. The American Senate has already given clear evidence of a realistic approach to the post-war world and of constructive rather than isolationist thinking about international relations.

That process must continue and be fostered by exchange of visits and by the mutual study of the common problems in a spirit of good will and understanding of the difficulties peculiar to each great democracy. What is somewhat disconcerting is to find that in the specific instance of the International Labour Organisation, in spite of the tributes paid to it by Sir William Jowitt and Mr. Eden last December, scarcely anything has been done to strengthen it and develop it into the main instrument giving effect to Article 5 of the Atlantic Charter. Plans for enlisting the services of the International Labour Organisation scarcely exist, and in spite of these public tributes there has been a lamentable failure on the part of the Allied Governments chiefly concerned—Great Britain and the United States—to strengthen the Organisation and fit it to perform the tasks which are to be entrusted to it.

The contrast between the tributes paid on all sides to the work of the International Labour Organisation and this comparative neglect or inactivity is emphasized when we recall that, at the great conference in New York in October 1941, it was declared that the International Labour Organisation is peculiarly fitted to help in such tasks as the feeding of peoples in need, the reconstruction of devastated countries, the restoration of industry, the resettlement of populations and the raising of standards of living. The Organisation received a social mandate, and in April 1942 the emergency committee of the governing body met to carry a stage further the work begun in New York. Twelve months later, however, it appears that the international committee which, by the decision of the London meeting, was to be charged with the study of how to apply Article 5, has still to be constituted.

There would be less anxiety at this slow pace if there were substantial evidence that the Allied Governments were active in their planning on other lines. There is something to be said for an approach by committees within the United Nations rather than within the framework of an organization which includes non-belligerents and neutrals. The existence of certain technical difficulties, however, has to be set against the overwhelming advantage of the International Labour Organisation in the association of organized employers and workers on equal terms with Governments. Mr. Eden's statement on his visit to the United States did little to meet this basic charge, but he at least quoted with approval Mr. Sumner Welles: "We cannot afford to permit basic issues by which the destiny of mankind will be determined to be resolved, without prior agreement, by a group of harassed statesmen working against time".

More positive encouragement may perhaps be drawn from the White Paper "Proposals for an International Clearing Union" which was issued by the Government for discussion by the United Nations. The main proposals refer to the establishment of a Currency Union based on international bank-money called bancor, fixed (but not unalterably) in terms of gold and accepted as the equivalent of gold by the members of the Union for the purpose of settling international balances. The proposals are formed to cover one of the main lines of approach to the post-war transition from relief and urgent reconstruction into the normal world, but the White Paper recognizes that the Clearing Union might become the instrument and support of international policies besides those with which it is primarily concerned. *It might become the pivot of the future economic government of the world.* It might, for example, set up a clearing account in favour of international bodies charged with post-war relief, rehabilitation and reconstruction, and supplement this by granting preliminary overdraft facilities in favour of these bodies. The Union similarly might set up an account in favour of any supernational policing body which may be charged with the duty of preserving the peace and maintaining international order. It might set up an account in favour of international bodies charged with the management of a commodity control, and finance stocks of commodities held by such bodies. It is all to the good that almost simultaneously there should be announced in the United States a second plan for debate, namely, a World Stabilisation Fund.

The White Paper, in fact, brings us back to the critical examination of the very foundations of British foreign policy to which attention was directed in a recent broadsheet of Political and Economic Planning. The basic pre-suppositions of our foreign relations in the nineteenth century which permitted a remarkable stability and continuity of policy can no longer be accepted as valid. The very fundamentals of our policy have to be re-thought and new presuppositions hammered out which will permit a similar continuity of policy in the coming years. This means, as the broadsheet reminds us, thinking in terms, not merely of this year and next, but of decades and even half-centuries, as well as of the whole range of relations—political, economic, social and cultural.

The main elements which have affected foreign policy in this way are, first, the high degree of integration and interdependence in human affairs which technical advance has brought about, with the consequence that many of the shibboleths of nineteenth century ideology have become meaningless. Secondly, the functions of the State are no longer restricted to the maintenance of internal order, external security and the conduct of diplomatic relations. The breakdown of much of the old distinction between the political and economic spheres has vital consequences for foreign policy. The closer interdependence of domestic and foreign policy involves a corresponding change and development in the machinery as well as in the personnel for handling these relations.

Besides the formidable combination of material and human resources which a nation must possess to qualify for the onerous role of world power, the broadsheet insists on the importance of capacity for leadership and the moral element in power. If there is any validity in the idea of the twentieth century as the century of the common man, this moral element must become increasingly fundamental to the whole concept of power and its exercise in the modern world. Not the least important task awaiting the framers of our foreign policy is the exercise of imaginative leadership which will ensure the effort required to remedy some of our more intangible weaknesses in this field.

As we must acknowledge the impact of changing conditions on our geographical position, so we must learn to think of ourselves as more than ever a European Power with new and heavy responsibilities in Europe, and the obligation to work out a new and enduring relationship with the peoples of Europe. Further, we must recognize that the conditions of the twentieth century call for a new type of relationship between the advanced and the less-advanced peoples. We have a particular responsibility for working out that relation; we must set out to do so without delay and to apply the results, in co-operation with the other World Powers.

No reader of the considerable volume of literature dealing with international reconstruction can fail to be impressed with the extent to which the consensus of opinion appears to be settling on exactly these principles. Broadly speaking, they are to be found more or less explicitly in Harold Butler's "The Lost Peace" and in Viscount Cecil's "A Great Experiment". They are largely common ground with the argument of Sir Rowland Hill's more recent "Prelude to Peace". There is, in fact, already a great measure of agreement with the view advanced by Political and Economic Planning that common policy and mechanism must invariably satisfy two tests: it must be designed to meet some real and basic need which is common to ordinary men and women everywhere; and it must also be capable of giving concrete results commensurate with men's expectations.

Sir Rowland Hill in his argument goes further than Sir John Williams and faces the problem of neutrality and of the smaller nations which Prof. Carr puts so clearly in "Conditions of Peace". His proposal for a Council of the United Nations is essentially that of building the framework of the new world order out of the institutions set up to win the War itself. That is his first solution to the problem of ensuring that adequate force, on which Mr. Herbert Morrison insisted in his Guildhall speech in February, is behind the institutions of order, though like P E P he relegates to the distant future any idea of formal federation. The essential co-operation between Great Britain and the United States and the U.S.S.R. must be less formal but based on full and an enduring understanding.

This co-operation for world order to ensure freedom from fear must, however, be complemented by the emergence of common purposes and positive, creative policies which will supply the dynamic of the new system. Moreover, national schemes and policies of social security must be framed with the full knowledge of the methods and experience of other countries, and on lines which will help and not hinder similar developments elsewhere. This is one reason why the wider development of the International Labour Organisation is so urgent. It is another reason for obtaining a clear and positive picture of the role we are best fitted to take in the new world balance—the recognition, as P E P points out, that we are now first and foremost a processing and servicing country, earning our living by adding brains and skill to the raw products of the earth; and that our special advantage lies in our exceptionally high level of technical skill, ability for organization and quality of workmanship.

The vital problem now is to educate the country as to what is involved in any policy that can adequately serve the needs of Britain and her partners in the task of rebuilding the world when the War is won. That task of education should be shared by every citizen who realizes the tremendous issues involved. The Government's part is to strengthen the instruments, such as the International Labour Office or other organs established during the War, by which collaboration can be pursued. Lord Cranborne's statement in the House of Lords on April 15, though in general terms, clearly committed the Government to explore every possibility of strengthening existing organizations and developing new instruments designed to ensure that the new international system based on free co-operation has behind it the overwhelming forces required to maintain the peace.

HIGH POLYMERS

Natural and Synthetic High Polymers

A Text-book and Reference Book for Chemists and Biologists. By Prof. Kurt H. Meyer. Translated by Dr. L. E. R. Picken. (High Polymers, Vol. 4.) Pp. xviii+690. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1942.) 11 dollars.

SOME twelve years have elapsed since the appearance of Mark and Meyer's book on "Der Aufbau der hochpolymeren organischen Naturstoffe". The subject has since expanded to a very large extent, and the present volume in this series of monographs claims to survey "the entire field of natural and synthetic, inorganic and organic high polymers". In point of fact this is, of course, strictly the object of the whole series of volumes on high polymers, of which this is the fourth volume. The survey must, therefore, be severely restricted in many directions, but none the less, like all the books in the series, it is complete in itself. In a way this attempt at giving a complete treatment tends to some considerable repetition from volume to volume, thus using up valuable space which might otherwise be occupied.

As one might expect, a volume from the pen of K. H. Meyer is mostly devoted to the chemistry of the natural high polymers. The chemistry of these substances is the main and most valuable feature of the book, which is concerned with the structure and reactions of high polymers and not with their synthesis. The opening chapters deal with the principles of the methods of investigating high polymers by X-ray analysis and by the behaviour of their solutions. Similar topics have been discussed in detail in volume 2 of the series, where the reader must go in order to get an account of the techniques involved. This particular part of the volume might, therefore, have been transferred to volume 2. Inorganic polymers are given an appropriate section wherein existing knowledge is summarized. One result of the recognition of the essential polymeric nature of substances, like certain varieties of sulphur and of phosphorus, has brought to an end long-standing controversies by inorganic chemists regarding the size of the molecular aggregates comprising these solids. This result is unambiguously arrived at solely by X-ray analysis of the structure of the solid. Some space is also devoted to the silicates, more with the object of showing how in inorganic chemistry there is a complete set of polymers analogous to organic materials obtained synthetically and existing naturally. It is a controversial point whether silicates should find a place in a book of this character. No mention is made of that interesting class of polymers lying, in a way, intermediate between organic and inorganic chemistry, namely, the products obtained by the hydrolysis of the methyl silicon chlorides.

More than 130 pages are devoted to high polymers excluding cellulose and the proteins, a large part of which is already adequately treated in volume 3 of the series. But in this discussion there is much that has not appeared elsewhere. For example, the structure and reactions of natural and synthetic rubber are discussed in some detail, as is the thermodynamic theory of the high elasticity of such polymers. While all this discussion is relevant, the reviewer would suggest that in the near future a volume might well be devoted to the scientific, rather than the technological, treatment of this important branch of polymer chemistry. Considerable compression has been necessary to get a description of polyesters, phenol and formaldehyde resins and the products of polycondensation reactions in a matter of twenty pages, which is too condensed to be useful.

All this material none the less forms a useful introduction to the real purpose of the book, namely, a most thorough and illuminating survey of the chemistry of cellulose and its derivatives and of proteins. In so far as cellulose is concerned, the author is at once confronted with the difficulty that science and technology are intimately bound up with each other. Another volume is promised on cellulose, presumably on the technological side, and consequently Prof. Meyer has confined himself strictly to the chemistry of cellulose and the derivatives obtained by chemical and also mechanical treatment. This discussion naturally paves the way for an examination of that enormous variety of substances related to cellulose but not hitherto subjected to the same detailed scrutiny. Starch, chitin, hemicellulose, pectin, lignin and gums come within this category. It is here that close collaboration between chemist and biologist is most likely to clear up many of the ill-defined points of view held about the structure of such materials.

In the section on the proteins a very broad treatment is given. There is only brief mention of the methods of determining molecular weight, which in any event has been dealt with adequately in a number of publications. The structure and reactions of fibrillar and globular proteins is discussed at some length, with due emphasis on the high polymer point of view. The electrochemistry of protein solutions—once a part of classical colloid chemistry—automatically finds its place in this section of the book. Of more interest to the biologist are the sections on conjugated proteins, proteins with enzymatic properties and the various virus proteins. There is a break in the arrangement of the book at this stage, and the sequel to the natural high polymer section is found in the last chapter on the molecular structure of animal and plant tissues, or rather the submicroscopic morphology of such tissues. For want of information, the chapter is necessarily short; but it is the point at which the biologist will be able to start using the data and ideas presented in the remainder of the book in order to make his contribution to the solution of these structural problems.

The interlude mentioned above should have been transferred to the beginning of the volume, since it deals with the properties of solutions of high polymers n general. It overlaps, but is complementary to, a somewhat similar chapter in volume 2. The main topics are, of course, the solubility, vapour pressure and osmotic pressures of their solutions, since the separation of heterodisperse polymers and the estimation of molecular weight can only be confidently carried out provided there is in existence a sufficient amount of knowledge concerning these solutions. The viscosity of dilute solutions is also a relevant topic here. A critical and extended discussion on this phase of the work would have been welcome. The Staudinger equation has come in for a good deal of criticism, often uninformed, and it would have been extremely useful for the many who are forced to employ this method for measuring molecular weights, out of convenience, to have had a critical summary of this very controversial subject.

In short, therefore, this volume is a mine of nvaluable information and suggestive commentary on high polymer systems, especially in those regions of contact with the biological side. For the biologist t is appropriately complete in itself; for those nterested primarily in high polymers the other volumes in the series will satisfy all reasonable needs where volume 4 is somewhat abridged. The work of ranslation has been excellently done by Dr. L. E. R. Picken. The author, translator and publishers alike must be accorded a word of gratitude for having produced, under most difficult international conditions uch a valuable addition to this series of volumes.

H. W. Melville.

VENEREAL DISEASE IN GREAT BRITAIN

Venereal Disease in Britain

By Sydney M. Laird. Pp. 80. (Harmondsworth and New York: Penguin Books, Ltd., 1943.) 9*d*. net.

Dr. SYDNEY LAIRD'S views on the subject of control and compulsion as a means of reducing he incidence of venereal diseases have already been presented by him to his colleagues in venereology. His expressions can be taken as a fair cross-section f specialist medical opinion. This book is a statement of facts and an appeal to the reader to apply the knowledge he can obtain in his reading to the task—his public duty—of helping to reduce the amount of venereal diseases. Elimination of the stigma attached to the diseases must accompany the newspaper and radio drive to increase the public knowledge of the subject. A short outline of the historical background precedes a simple explanation of the ommon signs, symptoms, and complications of gonorrhœa and syphilis. A typical case history lustrates the train of events which follow when an gnorant man is exposed to infection. The reviewer an vouch that the example chosen is no unlikely heoretical case.

The treatment of venereal diseases by well-meaning ut uninstructed general practitioners—increasing ince the advent of M and B 693—is justly decried.

Venereal diseases are not notifiable in Great Britain. Free diagnostic and treatment facilities are provided, but the sufferer must voluntarily present himself, and if he defaults from treatment while still nfectious there is no way of compelling him to return. This voluntary system has had a very long time in which to prove itself, and the 70 per cent increase in the incidence of early syphilis since 1939 has proved its complete inadequacy to deal with the present situation. Regulation 33B aims only at a very small section of the community and is unlikely to make a noticeable impression.

The successful Swedish venereal disease control system is described. Treatment is compulsory, but facilities are free both for out-patients and for in-patients. Notification does not disclose the patient's name. The source of infection and any contacts of the infectious person can be compelled to attend for examination and for treatment if necessary. Legal powers are available to deal with anyone who defaults from treatment while still in an infectious state. In practice 97·5 per cent of cases attend until they are certified free of venereal disease in a communicable form, and legal intervention is very rarely needed. Compare this with an instance in an English clinic—a fair specimen—where 50 per cent of syphilis and 30 per cent of gonorrhœa cases defaulted before treatment was complete.

Dr. Laird asks for education of the public and for compulsory powers run on the Swedish pattern, which will, of course, rarely be used in an enlightened community. The medical facilities are already available and adequate.

Finally, there are some illustrative statistical tables, British and Swedish, and a résumé of the relevant clauses of the Swedish anti-venereal laws.

The first half of this book should interest and inform any lay reader, and it is to be hoped that the second half will have the author's desired effect of stimulating the intelligent reader into individual effort in helping to stamp out venereal disease.

PROTECTION OF ELECTRIC POWER SYSTEMS

Automatic Protection of A.C. Circuits

By G. W. Stubbings. Third edition, revised. Pp. viii+320. (London: Chapman and Hall, Ltd., 1943.) 18*s*. net.

THERE are not so many text-books on circuit and machine protection that the present edition of the author's well-known work is not welcome, especially as it has been brought right up to date. The potential power in modern rotating machinery and transmission circuits is so great that one need not wonder at the simplicity and robustness of the design, maintenance, and testing of the apparatus which is relied on to prevent a major disaster on a fault developing and spreading. At the same time that faulty elements in a system are de-energized by the protection system, it is evident that power must be maintained in as much of the rest of the system as possible. The author therefore outlines the development of protection, the design and interconnexion of the necessary voltage and current transformers, and gives a full description of the relays necessary for the sequential or distance control of the circuits to be protected. A chapter on symmetrical components is given so that protection schemes depending on this conception may be the better appreciated. The author concludes his useful survey with an account of the protection of plant, testing, references to relevant literature, and a glossary of the technical terms used in the art. The stability of power supply in Great Britain and the rarity of major breakdowns is the result of the careful application of this protection technique.

L. E. C. Hughes.

MENTAL ATTITUDES IN WAR-TIME

THE programme of the general meeting of the British Psychological Society, recently held at Oxford, contained a symposium on "Mental Attitudes in Time of War". Prof. Millais Culpin and Prof. Gilbert Murray took the chair in succession.

Dr. R. H. Thouless spoke on "Hatred of the Enemy". One of the social and psychological results of the situation of being at war is the development of an attitude (or sentiment) of hatred of the enemy. In this sentiment there are the characteristic emotional dispositions of hatred, leading to anger at the enemy's successes and joy at his misfortunes, and the corresponding behaviour impulses to injure and destroy the hated enemy. The existence of such a system of emotional dispositions is not peculiar to this War, but is a feature of all wars; it was strongly developed against the Boers in the South African War and against the French in the Napoleonic Wars.

While this hatred is undoubtedly fostered by propaganda during any time of war, there is no reason for supposing that it is simply a product of propaganda. There are undoubtedly internal causes previously at work in people's minds which serve to make the propaganda of hate effective. The internal causes which have been principally considered by psychological writers have been the instinctive or unconscious forces of human aggressiveness. Upon these, however, have been built a structure of fully conscious ideas which may be strengthened or weakened by the use of conscious methods.

The social psychologist must ask himself if in war-time the sentiment of hate is desirable or undesirable; not only whether it attains immediate special and political ends but also whether it is reasonable and good in itself, that is, furthers permanent social well-being.

On one obvious ground, hatred of the enemy can be defended, namely, its service towards the important and desirable end of defeating the enemy by strengthening the intensity of war-effort and providing a motive for enduring the hardships of war. Against this social gain must be balanced serious social and psychological losses. First, war is a transitory pattern of behaviour, succeeded by the relatively lasting pattern of peaceful co-operation. The continuance of the hatreds of war beyond its end, and their effect on the subsequent peace treaties, is a powerful factor in producing the next war. Secondly, belief in the legend of the hated enemy, which is the conscious aspect of the impulse of hatred, produces an irrational picture of the enemy as altogether evil, with refusal to discriminate between good and bad individuals within the hated group. Examples are Hitler's condemnation of the hated Jews and the condemnation of all 'Germans' by some speakers and writers on our own side. It involves a failure to face the real facts of the war situation, and may be a barrier to our taking advantage of the enemy's disunity. A third way in which hatred of the enemy interferes with a realistic attitude towards the problems of making a lasting peace is the tendency to regard the present hated enemy as the one menace to world peace in the past and in the future. History may show that the hated enemy of the moment was a valued ally in the struggle against another enemy in the past (as were the Prussians in the Napoleonic Wars) and that the aggressor of twenty years hence may be some nation other than the present enemy. The attainment of a lasting peace cannot, therefore, be expected to be achieved by the mere defeat and disarmament of the present enemy.

The practical results of hatred in prolonging bitterness and making difficult a satisfactory peace may be regarded as secondary consequences of the fact that hatred is evil in itself—a regressive attitude which blinds judgment and leads to the evil consequences of harsh peace terms and continued bitterness between nations. If, as social psychotherapists, we consider the question of attitudes in war-time, we must condemn hatred and try to devise means for reducing its strength. The unconscious causes of hatred are largely beyond our control; but rational analysis of the legend of the hated enemy can show that much of it is without basis in fact.

There seems insufficient ground for supposing that this process, if successful, need lead to any reduction in effective effort towards winning the War, for effective action need not depend on irrational impulses. There are rational as well as irrational grounds for desiring an Allied victory in the War. Irrational hatred of the enemy is generally least strong among front-line fighting troops, probably because these do not suffer from that frustration of the impulse to action against the enemy which raises the sentiment of hatred to pathological intensity. One difference between this War and that of 1914–18 is that there are now far more active participants in the War and therefore fewer people whose aggressive impulses are frustrated. This gives reason for hoping that there will be fewer irrational haters.

Prof. T. H. Pear discussed the psychological implications of "Re-educating the Germans" after the War. Relevant questions were: Which Germans ? How ? By whom ? For how long ? If the re-education is to follow a plan, its form will ultimately depend upon the attitude which a small group of leading men has taken up during, as well as immediately after, hostilities. The Nazi youth is a nasty bit of work, but he is a bit of work; and that work was planned. Perhaps some of its methods might be used to achieve results more desirable to us.

Who are "we" ? In 1918–19 "we" appear to have been a group of tired men dominated by some who were less tired. To them, perhaps, there seemed to be no means of ascertaining public opinion except by an election. If other means had existed then, it is doubtful if they would have been used. It is difficult, for example, to believe that leading economists advised the Allies that the sums of money demanded by them could be paid.

Psychologists have a duty as well as a right to think psychologically about problems which concern the lives and happiness of millions, and to comment upon the use or misuse of specifically psychological concepts by persons in responsible public positions. If, only a few weeks ago, psychologists had asked "On what occasions have our spokesmen, when attempting to influence the public on problems concerning the future of the Germans, used psychological terms ?" one answer would have been, "On the radio —but not on the Home Programme. At home through more than half a million copies of 'Black Record' ". This brilliantly written and intensely interesting pamphlet distorts history, ethnology, sociology and social psychology in a manner which Dr. Goebbels has made familiar. Lord Vansittart's point of view is that of an extremely small section of English society. He makes practically no reference to the German working class.

On behalf of the Government, however, Lord Simon asserted in the House of Lords on March 10, 1942, that the Hitlerite State should be destroyed but that the whole German people is not thereby doomed to destruction.

No responsible social psychologist, Prof. Pear believes, would claim that the Germans have a special innate tendency to cruelty, possessed by members of no other nation. A particular type of education seems to have been responsible for the abominable behaviour of the Nazis. It is just conceivable that a relatively larger number of Germans than of other 'civilized' nations might have inherited a temperament specially conducive to learning the technique of cruelty, yet selective breeding to that end would take a long time, and so far would have produced no children above the age of ten. An individual's pugnacious tendency might express itself in bestial cruelty, if intelligently trained in selected techniques or merely in sports like boxing and football which are usually admired.

Prof. Pear suggested that Prof. Gordon W. Allport's doctrine of a relatively undifferentiated human drive* later modified by attitudes, sentiments, complexes, techniques, values and interests, explained the facts better than any appeal to a theory of human instincts. Allport considers that the many known facts about animal instincts only confuse the issue, because there is such flexibility in the human learning and breaking of habits, and so much insight, foresight and delay in responses, that human goals are of a different type from the stereotyped goals of animals. In the process of maturing, the dispositions of childhood coalesce into sharper, more distinctive systems of motivation. As they emerge, these personal, unique systems take upon themselves effective driving power, and operate as autonomous motives, different in aim and character from those of juvenile years and very different from the crude tensions of infancy. Blanket terms like 'aggressiveness' confuse too many psychological problems at present.

Prof. Pear deprecated some spatial metaphors in psychology, in such phrases as 'the *layers* of the mind', 'the *depth* of aggressive instincts', 'the cultural *and therefore more superficial* aspects of the individual in relation to society'. A pattern of activities which began because it was prompted by some comparatively primitive incentive may set up a stranglehold in its own right: stamp-collecting and bridge are good examples. The concept of the transformation of human motives seems to him to be most helpful. In war, too, many motives other than the unconscious ones are deliberately harnessed by authority. The desire for money or fame, the wish to obtain approval and to avoid disapproval from those one loves or respects, may be completely conscious and yet may inspire difficult feats. Both the fighter's and the scientist's activities may also show functional autonomy both in peace and war, complicating the problems of post-war reconstruction.

Dr. Ranyard West asked, "What ought we to Think?" He emphasized our large and increasing knowledge of mental attitudes peculiar to certain character-types within all societies. In particular, he stigmatized the role of the 'obsessional' or 'aggressive-obsessional' character both in pre-war and in war-time society. By virtue of the peculiar powers of hatred and passionate loyalty and devotion which the psychoanalyst now knows them to possess, these individuals are prone to the "black and white" type of thinking which war fosters and which fosters war. But in war-time, obsessional mechanisms of thought also become more apparent among normal men and women. The hideous injuries that in war-time must be suffered by our friends and inflicted upon our enemies virtually give us only two alternatives to "black and white" thought. One is to repudiate aggressive thought and action from religious motives. The other is to understand the inevitability of human prejudice in the presence of emotion. This leads to concentration upon the faulty situation itself.

Racial prejudice has been analysed by Stratton. He finds it nearly or quite universal. But he also claims that it has no innate direction. Nowhere, for example, have white children a 'natural' prejudice against a coloured nurse. It arises not because of any awareness of a difference of race, or even of strangeness, but always because of a feeling of group menace. It is proportionate to the social injury which one race-group believes another may do to it. The physical and cultural characteristics of the hated race thus become merely the signs and badges of an opposing group. The prejudice is a group-reaction to losses threatened or experienced, not inborn, but continued by tradition and by fresh impressions from new harm received.

This analysis transfers the 'racial' problem from a biological into a politico-economic category; and here the present custodian of the race is usually the nation. Nationhood is based upon many factors: geography, language, economy, a common heritage of history and habits. But above all there must be a common interest appreciated as such. "A nation is made and kept by an emotionally sustained education in nationhood. . . . And warfare among civilized nations is no mere persistence of something inborn, but a product and instrument of governmental art." Some of us to-day may be willing to substitute the less ambitious word 'action' for 'art'.

Here we have a welcome emphasis upon contemporary and controllable factors. Our national group-prejudices have their deepest root in the mere group. But in fact the nation State is a very peculiar group, a 'power' group which claims 'sovereign independence' from all other power-groups. The nation binds us first by fostered sentiment and traditional education and common interests. Secondly, it denominates a 'State' which monopolizes collective force within the nation. To the internal power of this State is now conjoined an external aspiration which is essentially undefined and unlimited. The doctrine of 'sovereignty' demands that the nation State itself shall both define and judge its own cause at the one and the same moment—and that moment will be one of intense emotional tension. In final paradox, both the limitless aspiration and the claims of sovereign independence exist in the presence of a real and severe limitation of external power. It is scarcely surprising that our nations come to fear each other.

Dr. West emphasized the fact that the human mind is endowed with ample machinery for maintaining its self-respect but with none for making accurate moral judgments in the face of emotion. He claimed that the distortion of factual judgment, inevitable between individuals, is increased between power-groups (1) because the prejudices become shared, and (2) because they lack the factual correction of third-party judgment and of law. "We have to face the fact that our enemies and we are judging our mutual relationships by a totally different set of 'facts' stretching backwards into the past, as if we saw only the green in a landscape and they saw only the red."

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* "Personality: A Psychological Interpretation" (Constable). Cf. Pear, T. H., "Are There Human Instincts?" (Manchester University Press (1s. 6d.), and *Bull. John Rylands Library*, 27 (1942).

The inevitable prejudice of human judgment finds a corrective in a natural love of justice. But this corrective requires (1) organization and (2) external application. The requisite institutional remedy lies in law, such as we already have it within our nation States. The inevitability of national prejudice requires that such law shall be organized and administered upon a supernational plane.

PHYSICS, MATERIALISM, AND FREE WILL

By Prof. L. SUSAN STEBBING

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SIR JAMES JEANS'S recent book, "Physics and Philosophy", has once more raised the question of the bearing of the 'new physics' upon the philosophical doctrines of metaphysical materialism and human free will. It is not a little odd that at a time when some philosophers are beginning to wonder whether it makes sense to say that materialism is true (or that it is false), and whether, therefore, it makes sense to say that idealism is true (or that it is false), some eminent physicists and mathematicians are asserting that the new physics provides arguments that are very strong, even if not conclusive, in favour of establishing the truth of metaphysical idealism. Thus, for example, Sir James Jeans concludes: "Modern physics is not altogether antagonistic to an objective idealism like that of Hegel"*. He further contends that the new physics has an important bearing upon the problem of free will.

These two contentions formed the main topic of discussion at the symposium held at a joint meeting of the London and Home Counties Branch of the Institute of Physics, the Aristotelian Society, and the Mind Association, on May 19. I gave the opening paper, which was replied to by Sir James Jeans; Mr. R. B. Braithwaite and Prof. E. T. Whittaker opened the discussion which followed. This article is not a report of the discussion, but an attempt to bring out the main points that were raised.

There is a preliminary question which usually receives far too little discussion, namely, what exactly is the relation of physics and philosophy. Not all philosophers would give the same answer to this question, nor would all physicists. What Sir James Jeans's answer would be is well known; he holds that metaphysics is literally 'beyond physics', so that the decision whether materialism is true or is false is one to be made by physicists. Since it is assumed that the denial of materialism entails the assertion of idealism, it can scarcely be maintained that the physicist *qua* physicist has a right to the last word. Before that last word is said, he must have become a philosopher and have acquired some skill in thinking philosophically. It is also desirable that he should have learnt to avoid the mistakes of earlier philosophers, which have been quite decisively refuted. Certainly any man of science may well be led to reflect upon certain great problems which have traditionally occupied the attention of philosophers—man's place in the universe, the ultimate nature of things, of matter and of mind, and of their interconnexion. Such problems have also exercised the minds of some great poets. In what sense these great questions are 'problems' can only be asked at a comparatively late stage of philosophical development. Physicists are sometimes tempted to take short cuts and to say more than they know.

Prof. E. T. Whittaker has made a very pertinent comment in this connexion. He ascribes the extraordinary popularity of the writings of Sir Arthur Eddington and Sir James Jeans not to their eminence as men of science, nor to their powers of exposition, but to the fact that, as he said, "they have a quality which is found, perhaps, most markedly in great poets, of having flashes of insight which reveal to them things which are beyond the range of exact knowledge. Whereas, knowing them to be eminent scientists, we imagine that what we are going to get from them is exact knowledge, we are delighted to find that they have a poetic insight."* This comment seems to me to be just. To keep to the case of Sir James Jeans, his philosophical reaction to 'the implications of the new physics' appears to be largely determined by his feeling that "the new physics shows us a universe which looks as though it might conceivably form a suitable dwelling-place for free men, and not a mere shelter for brutes—a home in which it may at least be possible for us to mould events to our desires and live lives of endeavour and achievement". These are not the remarks of a physicist writing physics; they are the reflexions of a physicist who is attempting to formulate a philosophy of life. It is from this point of view that they must be judged; criteria derived from physics will not suffice.

The old physics (that is, classical physics, which reached its consummation in the nineteenth century) is thought to be inimical to our desires because it is taken to involve the doctrine that the ultimate reality is matter and that mind is a mere epiphenomenon of matter. This doctrine has been associated with a strict determinism, that is, with the view that all events, including human volitions, are causally connected so that our thoughts and feelings could, in principle, be predicted; everything that happens is, in fact, nothing but a mere re-arrangement of the atoms that are the ultimate constituents of the universe, and alone are permanent. The 'prison-house' feeling, or what T. H. Huxley called "the nightmare", has been induced by the reluctant acceptance of materialism in this form together with the strict determinism associated with it.

Anyone who has accepted this metaphysical theory as an inescapable outcome of classical physics will be likely to welcome the new physics as being very relevant to the solution of his problem. It is, however, important to be clear with regard to what exactly the problem is. It appears to be the problem of escaping from the 'prison-house' into a world in which we may hope "to mould events to our desires". If the obstacle to this escape has been the acceptance of the view that the universe 'really' consists of indestructible atoms and that the perceptible variety of things in the universe and the perceptible difference between men, brutes, and, for example, rocks, are wholly due to differences in the arrangements of these atoms, all of which move in accordance with strict causal laws, then the possibility of escape begins to appear promising. The new physics has shown conclusively that this atomic conception is mistaken and that, to quote Prof. Whittaker, "determinism does not reign definitely in the physical world".

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* "Physics and Philosophy", p. 204.

* I quote from a verbatim report of the discussion, kindly provided for me by the chairman of the symposium. Prof. Whittaker went on to say that I had not altogether allowed for this fact. I think he is right in stressing this difference of temperament, and in insisting that I am not in the least 'poetic'. It would be interesting to learn whether Sir Arthur and Sir James are content to regard their excursions into philosophy as mainly poetic in quality.

It is at this point that the philosophy of Sir James Jeans becomes significant. His contention is that there is a new dualism of waves and particles replacing the old dualism of mind and matter. Readers of Nature will not require any exposition of this view. Philosophers will wish to ask why exactly Sir James Jeans holds that the 'wave-picture' is more fundamental than the 'particle-picture', and what is the logical basis of his contention that the waves are mental and the particles material, or, as he also puts it, that the wave-picture gives us *knowledge* and the particle-picture gives us *objects*. Further, on what grounds does he contend that the waves control the particles; hence that mind controls objects?

In claiming that the wave-picture is mental, Sir James Jeans seems to have been influenced by three considerations: (1) that the geometrical representation of the waves is more complicated than the geometrical representation required by classical physics; (2) that wave mechanics is a mental construct whereas particle mechanics either is not a mental construct, or at least is not a mental construct *in the same sense*; (3) that since the waves are waves of knowledge, the determinism involved in the wave-picture originates in part at least in our own minds. It is not clear whether Sir James Jeans considers that (2) follows from (1), but it seems that he must have done so. There is not, in my opinion, any good reason for this contention. Wave mechanics is just as much or just as little a construct as particle mechanics. Hence, if idealistic conclusions are to be drawn from the new physics, they could just as suitably be drawn from classical physics; in fact, they cannot suitably be drawn from either. (3) would appear to be jointly entailed by (1) and (2). Nothing in the discussion or in Sir James Jeans's book shows clearly what exactly are his views with regard to the nature of mathematics. At times he seems to suppose that a mathematical statement is a statement about something mental; at other times he suggests that "God made the mathematics and man made the rest" (in physics). However we interpret this cryptic utterance, it does not seem likely to support the conclusion that objective idealism is in the main correct.

Plain men, especially during the last two centuries, have been apt to take their philosophy from science, meekly accepting whatever scientific men tell them to believe, and thus they are led to deny the plain facts of their own experience if eminent men of science exhort them to do so. It is odd how easily plain men and scientific men alike forget the nature of the abstractions within which experimental science is carried on. Although plain men find difficulty in recognizing themselves as 'cogs in a machine', they see that, if the universe is a great machine, they must indeed be nothing better than cogs. They forget that physics is concerned with certain features in the universe, to the entire exclusion of other features. Accordingly, the rejection of the machine-image is hailed with delight as freeing us from the 'prison-house'. All this is very understandable, but completely without logical foundation. If this be correct, the bearing of the new physics upon the problems raised by Sir James Jeans is psychological; it enables him, and others, to *feel* differently about the position of men in the physical universe. It has, however, no bearing at all upon the question whether metaphysical materialism is false, or whether the assertion that metaphysical materialism is true or false is itself a statement without assignable meaning.

It may further be urged that, even if the new physics destroyed the basis of the nineteenth century denial of human freedom, there would still remain a greater obstacle to overcome, namely, the part played by man's glandular structure upon his activities. This contention, it may be noted, was not favourably received by the physicists.

BREAST AND BOTTLE FEEDING

ABOUT half the babies born in Great Britain nowadays are put on the bottle between the third and sixth months after birth; the proportion is increasing, but in spite of this the health of babies is undoubtedly improving. It is inevitable that a discussion such as that of the Nutrition Society on May 22 about nutrition in infancy should continually suggest the question: Is there any serious objection to stopping breast feeding after the first few months?

It is easy to suppose that, through thousands of years of selection, a mechanism has evolved that will provide the baby with ideal food, if the mother is supplied with the necessary materials in her own food. But evolution cannot anticipate changes in environment. Piglets kept in a bare sty become seriously anæmic in a few weeks; the sow's milk does not supply them with the iron they need, however much she may be taking[1]. In their natural state the piglets would pick up enough by rooting in the earth; in the sty they must be given iron in some form. Man takes his women and babies into equally unnatural environments which may impose demands that the mother's milk will not cover. The amount of vitamin D that is ample for a naked baby in a sunny climate may be wholly insufficient for a baby screened from ultra-violet light by clouds, smoke, house and clothes. It is possible that artificial milk might be prepared that would meet a modern baby's needs better than any human milk.

The disastrous results of artificial feeding in the past were due to dirt and infection with pathogenic bacteria. Milk supplies were filthy; bottles were not clean, often because they were so shaped that it was not possible to clean them; the baby drank an infusion of bacteria, dead or alive. Even if the bacteria were not pathogenic they did not agree with baby. In the last twenty years milk has become cleaner; much that is now supplied to cities is pasteurized; the pattern of bottles has improved and mothers have learned how to use them; house-flies have almost vanished with the horse from cities. These changes have taken away most of the terrors of bottle feeding and of the first few months after weaning. Nine years ago, Grulee[2] published figures to show that the death-rate of bottle-fed infants was nearly ten times as high as that of the breast-fed. But that was more than nine years ago and, as was pointed out at the Nutrition Society's meeting, Grulee made his investigations among the slum population of Chicago. The "slum population of Chicago" may not be so bad as it sounds, for Chicago had a remarkably low infant mortality-rate. Also the milk used was liquid milk; dried milk would have been safer. In this instance the conditions and method of artificial feeding were at fault. With improvement of social conditions and of methods many of the objections to bottle feeding disappear.

There remain the differences in the composition of human and cow's milk. Cow's milk contains less vitamin C and, if diluted, less A and D. However, some of the worst cases of rickets that are seen nowadays are among breast-fed babies. Both breast- and bottle-fed babies can now get fruit juices and cod liver oil that supply more of these vitamins than they could get from their mother's milk; so there can be no objection to artificial feeding on this score. Even if diluted, cow's milk supplies more riboflavin than does human milk. But calves grow faster than babies; cow's milk is more a growth and less a maintenance ration than human milk; it contains a higher ratio of protein to calories. Also the protein of cow's milk is mainly casein, while two thirds of that of human milk is lactalbumin. In the past, stress has been laid on differences in the amounts and physical properties of these proteins. Cow's milk has been diluted to reduce the protein concentration; cream and sugar have been added to keep up the caloric value; citrate also might be added to prevent clotting. But it is doubtful whether the baby is interested in physical properties; it was the bacteria, not the clots, of cow's milk that its stomach resented. After digestion, proteins are equivalent to mixtures of amino acids. Human milk and cow's milk, diluted to the same protein concentration, differ significantly in the amounts of certain of the amino-acids that they supply. This difference in proportion may affect the synthesis of proteins in the rapidly growing organism. Jeans[3], on the basis of the studies of Catherwood and Stearns[4], considers that babies that are given cow's milk in quantity sufficient to cause a high nitrogen retention have a larger muscle mass than breast-fed babies; although the breast-fed babies appear to be at no disadvantage owing to their lesser amount of muscle. If an artificially fed baby retains no more nitrogen than a breast-fed baby, its motor development is less good. The quality of the muscle seems to depend on the amino-acids of the milk. The evidence is not conclusive; but these studies suggest more sensitive tests of the biological value of proteins than are afforded by measurements of nitrogen retention and gain of weight. Further studies might be made on other animals or on identical twins.

A point that was stressed at the meeting was the importance of giving a baby enough food. Here artificial feeding has the advantage; for whereas human milk varies widely in composition and amount, cow's milk has a relatively constant composition, the amount given can be measured and can be increased if necessary. Forty years ago, when breast feeding was more common, one of the standard jokes was that of the baby that cried at night. The joke is now unfashionable; may it not have lost its appeal because mothers who cannot satisfy their babies now give them a bottle and have a quiet night?

It is usual to ascribe the adoption of bottle feeding to selfishness and laziness. But breast feeding is far less troublesome even than careless bottle feeding. The investigations made in Birmingham by the British Pædiatric Association showed that only 11 per cent of women gave up breast feeding owing to going to work. The most common reason given for stopping breast feeding is inability to satisfy the baby. This takes us back to the subject of the previous discussion at the Nutrition Society on "Nutrition in Pregnancy". The Toronto workers found that 86 per cent of well-fed mothers, but only 59 per cent of those on a poor diet, were suckling their babies six weeks after delivery. The ability to feed the baby well may be one of the best criteria of adequacy of the mother's food. After delivery the involuntary sacrifice of the mother to the baby is less complete than before; the milk begins to deteriorate before the deficiency of the diet becomes extreme. Yet, the demands on the mother are heavy; Ellison and Moore[5] have estimated that the total drain of vitamin A during nine months lactation amounts to 300,000 international units. The average figures given by Dr. Kon imply a daily loss of some 1,000 units of vitamin A and, in winter and spring, 17 mgm. of ascorbic acid per day—a considerable fraction of the vitamin A and more than half the ascorbic acid provided by the day's food. The milk supplies some 400 or 500 calories per day. If the mothers continue on a diet no better than those of pregnant women which were collected by McCance, Widdowson and Verdoe-Roe[6], it must be almost impossible for them to continue, day after day, to spare so many calories. The fashion of disparaging and discouraging the consumption of starchy foods, which must provide the bulk of the calories of the food of all but the wealthy, may have made nursing more difficult. It is not surprising that many mothers, voluntarily or involuntarily, fail to keep up this heavy drain on their own nutrition. Prof. Spence fears that this early termination of the natural reproductive cycle might, in the end, have disastrous results. But we have already interfered profoundly with the natural course of reproduction. It may be that earlier departures from Nature contribute to lack of ability or will to suckle babies for more than three months.

Undoubtedly, when clean cow's milk cannot be got, when housing is inconvenient and insanitary or the mother careless or stupid, bottle feeding is dangerous. Without definite evidence that the welfare of baby or mother suffer from artificial feeding, using proper methods and under suitable conditions, the choice must be left to the mother; the duty of public authorities is to recommend the proper methods and see that the conditions are favourable, particularly that the cow's milk is clean. If breast feeding has advantages over bottle feeding, however done, these advantages should be explained by people who seem to the mothers to understand their outlook and difficulties—as Prof. Spence said, not men and childless women; and again conditions must be favourable for the secretion of a good supply of milk. In either case the first essential is to provide a favourable environment—to get rid of slum housing and slum food.

Dr. Magee of the Ministry of Health could claim that a great advance had been made in this direction during the war years. Little can be done, for the present, to improve housing, but the system of food control, the national milk scheme and the provision of cod liver oil have improved the diet of pregnant and nursing women. The poorest can now get, free, more milk than was drunk by any but a few of the richest mothers whose diets were studied in 1937[6]. Dr. Magee's tone contrasted happily with that of a chief medical officer to the Ministry of Health ten years ago: "It will be realized that with an infantile mortality-rate of 64 per thousand no spectacular improvement can be expected"[7]. In 1942, the infantile mortality-rate in England and Wales fell to 49—lower than in any year before. This in the third year of a major war, with a rising birth-rate, is not merely spectacular; it is an achievement without parallel in history. The newer knowledge of nutrition has been applied and is justified by the results. Dr. Magee justly gave the credit to those who, brick by brick, have built up this modern knowledge. The first part of this meeting may have seemed a tedious fussing about details; but on these details policy must be based. Much remains to be done, particularly on this question of the relation of breast feeding to the nutrition of the mother.

The national milk scheme and provision of vitamin preparations are not isolated benefits to a small section of the people. With the provision of milk in schools and school meals, they are outstanding steps in the general policy of food control which aims at ensuring food according to physiological needs; they may be the beginnings of a future world policy. It seems that the Food Conference at Hot Springs will not descend to bargains to limit production similar to the wheat and sugar schemes of the past, but will fulfil its promise that the peoples of the world will work together to increase production and adjust distribution to abolish want. If so, our achievement in the midst of this War may stand as a record for all time; not because the mortality of infants, breast- or bottle-fed, will not fall far below 49 per thousand, but because a major cause of war will be no more.

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[4] Catherwood, R., and Stearns, J., *J. Biol. Chem.*, **119**, 201 (1937).

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[6] McCance, R. A., Widdowson, E. M., and Verdoe-Roe, C. M., *J. Hyg.*, **38**, 597 (1938).

[7] Annual Report of the Chief Medical Officer of the Ministry of Health for the year 1933, p. 9.

INDIA'S MINERAL RESOURCES

By Sir LEWIS FERMOR, O.B.E., F.R.S.

LIKE the British Association, the Indian Science Congress Association meets annually, moving from one important centre to another; this year the Association met in Calcutta for its thirtieth session. Mr. D. N. Wadia, owing to unforeseen circumstances, created a record by holding the office of general president for a second term. His address as general president during the first of these years was concerned chiefly with the geological origins of India (see Nature, December 19, 1942, p. 725). His second address (see Nature, May 15, p. 548) dealt with more general matters, only touching on the mineral resources of India. The president of the Section of Geology and Geography, however, Dr. J. A. Dunn, of the Geological Survey of India, gave an address on "Suggestions for the Future Development of India's Mineral Resources" (*Proc. 30th Ind. Sci. Cong.*, Part II, Section IV, pp. 1–22; 1943). This is a subject of interest to all who have been concerned with Indian minerals, and one that has, therefore, been discussed previously on numerous occasions. Dr. Dunn has, however, devoted so much of his career in India to the survey and study in the field, as well as in the laboratory, of several of India's principal minerals, that his views must be of value.

Any suggestions for the future development of the mineral resources of a country must be preceded by a statistical stocktaking. The fog of war has, however, descended upon India's statistics of mineral production, the latest published review being that for 1938. This withholding of statistics is in contrast to the practice during the War of 1914–18, when the usual reviews were published annually. The necessity for the present statistical secrecy seems doubtful. Dr. Dunn has met the situation, in what will be to some the most interesting part of his address, with a table showing the relative pre-war mineral production of India and of the principal nations. This table shows the relative production of fifty-four metal and mineral substances by India, the British Empire, the United States, the U.S.S.R., France, Germany, Italy and Japan. The production is not shown by actual figures, but by symbols indicating degree of excess, sufficiency or deficiency, the terms used referring, of course, to a country's output compared with its internal needs, excess justifying export, and deficiency causing import.

According to this table, India has world control in mica, monazite and titanium (ilmenite); a large excess of chromite, kyanite and sillimanite, and manganese ore; an excess of beryllium ore, columbite-tantalite, gold and magnesite; and a sufficiency of barium, bauxite, coal, felspar, fuller's earth and bentonite, graphite, gypsum, iron ore, salt, talc and tungsten; whereas supplies of all other minerals are deficient or negligible. Although all would not apply these labels as used by Dr. Dunn, they give an idea of India's position with reference to the world's mineral supplies, and in particular show which minerals she can afford to export, which she needs for internal use, and which she must import if she is to attain and maintain a balanced industrial economy.

The one mineral of which the classification might be altered is gold, in view of the fact that over a long period of years India was a sink for gold obtained mainly by import; and as the Indian output of new gold (from the Kolar goldfield) is a small one, such exports of gold as have taken place since Britain and India left the gold standard have been mainly from hoards of gold previously imported.

Deductions to be drawn from statistics of mineral production, exports and imports, concerning the metal requirements of industrialized countries, are liable to be vitiated, at least partially, by the increasing part that scrap metal plays in modern industry, adequate statistics of which are not published by any country except the United States of America. Dr. Dunn does not refer to this problem, probably because it has not yet arisen to any major degree for India, which has not long become one of the industrially developed nations. The above reference to gold shows that hoards of precious metals such as gold and silver—although not to be regarded as in any sense a form of scrap—play a similar part to accumulations of scrap metal in tending to vitiate deductions concerning the mineral economy of a country based on the study of mineral statistics that do not take account of the existence of accumulated stocks of metals, either as such or in the form of scrap metal available for return to industry.

Dr. Dunn next discusses the distribution of minerals in India, a country that illustrates in miniature the world's unequal distribution of useful minerals. For in India 40 per cent of the total mineral output comes from one province, Bihar, with its large deposits of coal, iron ore, limestone and mica, and its smaller quantities of copper ore, chromite, bauxite, kyanite and manganese ore. Advocates of the subdivision of India forget the witness of geology and minerals; for all parts of India are economically interdependent, requiring a co-ordinated mineral policy applicable to the country as a unit. Amplifying Dr. Dunn, one may say that from the mineral point of view the effects of the mutilation of the Indian geological unit by the amputation of the Burmese arm must not be enhanced by the additional subdivision of India, without provision for some form of central geological and mineral control.

The major part of this address is that in which Dr. Dunn discusses each mineral in turn with reference to the possibilities of expansion of production and treatment in India, if economically suitable. Quoting the author:

"At least four minerals now mined in India—mica, manganese ore, ilmenite and monazite—are of great importance to the world's industries, but to date almost their entire production has been exported in the unmanufactured state. These minerals must continue to be exported, but it is eminently desirable that much of the manufacturing processes through which they eventually pass should be completed in India before export. Within this country [India] there is nothing to prevent the gradual expansion of the micanite trade from mica splittings, or the manufacture of titanium white from ilmenite, or the extraction of thorium oxide and cerium from monazite, or even the smelting of much of our manganese ore to ferromanganese."

To this Dr. Dunn very wisely adds a rider: "the main problem would be in ensuring that other countries accept the Indian manufactured material in place of the raw material". The danger in such cases always is that an importing country, rather than lose the benefits of treating imported raw materials, would if possible turn to an alternative source of supply from another country, helping its development if necessary.

Among other mineral substances discussed sulphur may be mentioned, for one of the most important industrial requirements of India is an adequate supply of sulphuric acid, the keystone to so much chemical development. Until recently this commodity has been manufactured from imported sulphur. During the present War, the situation has been helped by the development of the natural sulphur deposits of Baluchistan, due to the initiative of Sir Cyril Fox as director of the Geological Survey of India. But the future important source of sulphur in India is likely to be the extensive deposits of gypsum, particularly those of the Salt Range in the Punjab.

In the remainder of his address Dr. Dunn discusses a number of other problems, such as the stimulation of prospecting, geophysical prospecting, and the possibilities of State aid in the development of the mineral industry. He also recognizes that in addition to a national mineral policy there is an international aspect of such policy, and that if India is to take her proper position among the nations she will have to conform to such general scheme of international mineral policy as may emerge from the post-war political framework. The discussion of such a policy has, of course, been initiated by the British Association, and the problem is now under consideration by the Mineral Resources Committee of that body appointed specially for the purpose.

THE SEARCH FOR NEW INSECTICIDES

By Dr. J. R. BUSVINE
Ministry of Health Entomological Laboratory

THE amusing definition of a specialist as "one who learns more and more about less and less" does not hold for the specialist in applied science. On the contrary, so far as I have observed in applied biology, it is a curious paradox that concentration on a single problem often requires the widest superficial knowledge of many subjects. For example, for the past three years I have been studying the effect of new insecticides on the louse. That would appear to be a fairly specialized problem requiring merely a familiarity with the biology of the louse and the physical and chemical properties of the organic chemicals proposed as insecticides. Actually the research led to a consideration of such diverse subjects as the psychology of the louse (and to some extent of the infested men who came to us for treatment), the risks of dermatitis from various chemicals and the possible carcinogenicity of oil diluents. The powers of absorption and retention of cotton, wool and cellulose acetate underwear were considered, and practical problems of laundering and dry-cleaning (especially the preparation of emulsions and the use of large centrifuges) came into the picture. Finally, one had to learn a little of such diverse subjects as army hygiene and women's hair-dressing styles.

It will be realized that, with such a bizarre series of ancillary problems, the biologist at work on a special control problem has little time to look for new insecticides; he can only test those suggested by others.

A search for new insecticidal compounds has been carried out since 1932 by the United States Department of Agriculture (about three thousand substances have been tested on a variety of insects). Apart from this, most of the work has been done in the laboratories of industrial firms. Very little of this work is published but, so far as one can judge, it is largely of an empirical nature. That is to say, of the large number of chemicals tested for suitability as insecticides, the majority are chosen on grounds of availability and the others because of chemical affinity to recognized insecticides. The reasons for the toxicity of these established insecticides were not investigated.

Fundamental research on the mode of action of insecticides has been neglected because it is difficult, and therefore slow. Many administrative men, both in industry and in Government departments, consider the work too academic. They pin their faith on systematized empiricism for getting quicker results. Opposing this extremely pragmatic outlook are those who have consistently urged that fundamental work is fruitful in practice. Certainly it must be admitted that the intensive empirical work of the last decade has left us, in war-time, with very few synthetic substitutes for the vegetable insecticides imported from abroad. It would seem that there is a very strong case for extending the fundamental research on insect toxicology.

As has been implied, the way in which insecticides act is very little understood. The subject can be explored by three kinds of investigation.

1. *Quantitative Experiments.* This type of research is, perhaps, easier than the others, because the

appropriate technical and statistical tools have been developed to meet the needs of the empirical work mentioned above. A good review of these methods has been given by Tattersfield[1].

The amount of poison which an insect can tolerate depends on its anatomy and physiology and is a characteristic of the species. This 'resistance' of the insect is greatly dependent on its state of metabolism, which in turn is affected by the environment. By varying the physical conditions and determining the effects on metabolism and on resistance the relationship between the two can be elucidated. In this way Cotton[2] showed the dependence of susceptibility of insects on their respiratory rate.

A great deal of quantitative research aims at measuring the doses of various poisons which will produce a certain toxic effect under standard conditions.

If these 'equi-toxic' doses are compared with the chemical constitutions of the poisons, something can be learnt of the toxicity of different radicals and the influence of structure on toxicity[3,4]. But even more suggestive is a comparison of the doses with physical properties. At first an almost embarrassing number of more or less close relationships were revealed. Lipoid solubility, capillary activity, volatility and molecular size all seem to have some connexion with toxicity.

Some of this confusion is a result of the complexity of poisoning processes. But considerable simplification was achieved by Ferguson[5], who pointed out that many of the physical constants involved were expressions of distribution of a substance between heterogeneous phases. These laws are involved because they govern the transfer of poison from an external phase to its seat of action in the tissues. By the use of chemical potentials as indexes of toxicity, Ferguson proposes a measurement better related to the actual dose in the tissues. This procedure eliminates some anomalies (for example, the 'cut off' in toxicity observed in ascending many homologous series) and it also differentiates sharply between chemically toxic and physically toxic poisons.

Another way of segregating poisons into different types is by comparing their equi-toxic doses to a series of different types of insect. For example, I have found that a range of insects shows the same order of resistance (say: *A*, *B*, *C*, *D*, *E*) towards intoxication by the vapours of a number of fat-solvent liquids. But quite different orders are characteristic of other poisons such as ammonia and hydrogen cyanide (say: *B*, *C*, *D*, *E*, *A*, and *E*, *A*, *C*, *D*, *B*, etc.). A significant fact, which seems to provide a clue to the mode of action, was that the insects displayed the same order of resistance towards asphyxiation by carbon dioxide as towards poisoning by the fat-solvent vapours[6].

2. *Observations on Individual Insects.* A great deal might be learnt from the careful observation of symptoms in individual insects. This type of work is too laborious to attract the attention of the practical entomologists, and the insect physiologist has been preoccupied with normal metabolism. Much remains to be done.

A very significant observation for developing fumigation was made by Hazelhoff[7] when he showed that the spiracles of insects can be kept open by certain concentrations of carbon dioxide. Likewise the application of contact poisons will benefit by the recent observations of Wigglesworth[8] on penetration of the insect cuticle.

Allied to the method of observing symptoms is the examination of pathological damage, particularly by histological means. The lesions produced by pyrethrum in nerve ganglia are evidence of the seat of action of that poison[9].

3. *Mechanical Models.* The experiments of Warburg in which gas exchange and poisoning effects in the living cell were paralleled by a charcoal model suggested the close relations of adsorption, respiratory processes and poisoning.

Quite recently Hurst[10] has used relatively simple physical systems to attempt to explain some observations on the entry of contact poisons. By ingenious artificial membranes and experiments with the Langmuir trough, it seems likely that light will be shed on the penetration of insecticides through the insect cuticle.

A word of caution, however, is advisable in mentioning the inferences to be drawn from mechanical models. As Clark[11] frequently stressed, the living cell is so complex that one must suspect any simple explanations of metabolism or of intoxication.

Fundamental research on toxicity involves some problems analogous to those of the *ad hoc* work. For example, both have to meet the difficulty of getting the poison to the vital spot. When insecticides are used in practice, a heavy dose must usually be employed which may be ten or a hundred times greater than the amount which will kill the insect 'in a test tube'. The heavy dosage is to allow for wastage and to ensure penetration to the insect, which may be buried in grain or hidden in a crevice in the wall. In the same way, the lethal concentration applied to the exterior of an insect is huge compared to the concentration in the tissues. If the practical dose is measured in pounds or ounces and the 'test tube' dose in milligrams, the amount which actually disrupts the metabolism can be reckoned in micrograms.

From what has been said, it is obvious that anything which will improve penetration by the known insecticides will add greatly to their effectiveness. It seems possible that some of the adjuvants or 'synergists' of pyrethrum which are not toxic themselves may act by accelerating entry of that poison. But the matter is little understood at present and the search for adjuvants proceeds quite empirically.

In another way the fundamental research resembles the applied work; both are constantly confronted with non-biological problems. The toxicologist is preserved from social and industrial diversions; his difficulties concern other branches of science, particularly physics, chemistry and mathematics (statistics). Like a barrister briefed for a technical case, he must read the various subjects to acquire a working knowledge. Unfortunately, the questions usually involve rather abstruse sections of the particular sciences. The statistics of toxicity require the special methods of small samples: the physics may concern monolayers or phase distribution; the chemistry is that of unusual compounds with formulæ like the more complex Chinese characters.

The only good solution of the difficulty is by collaboration between biologists and other specialists, if possible working on the same problem; certainly in the same institution. My experience is that half an hour's discussion with an expert is worth several days of poring over heavy treatises on an unfamiliar subject. Most biological research stations employ a full-time statistician for their problems. A physical chemist would probably be equally useful.

This is not to say that specialists should confine themselves entirely to their own subjects. Both parties must know the groundwork of the other subject for a collaboration to be successful. The specialization on insecticides research should resemble mountain peaks connected by ridges and passes, and not the isolated specialization of the branches of a tree. That is probably true for other types of research also.

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PRODUCTION OF MAGNESIUM

MAGNESIUM is to-day a metal of the greatest importance, and the paucity of reliable information regarding the production of this latest addition to the industrially important metals makes especially welcome the survey given by Dr. C. H. Desch in the Peter Le Neve Foster Lecture to the Royal Society of Arts delivered on February 17.

Magnesium, the lightest of all the industrial metals, is a new-comer to metallurgy. Although first prepared by Davy in 1808, it has only become really well known in the course of the present War, though its production had been increasing for some years before.

The pure carbonate is of only local occurrence, though there are very large deposits of a lower degree of purity. The double carbonate of calcium and magnesium, dolomite, is far more widely distributed, and sea water provides an inexhaustible source of the chloride in a dilute form, while certain concentrated solutions of magnesium salts occur in the Dead Sea and elsewhere.

The fact that magnesium alloys are available which are extremely light for a given strength renders the new metal one of great importance in all branches of transport engineering. The output of the United States is planned at a rate of some hundred times that of 1940, but the industry is far from being merely a war-time one and will certainly play a permanent part in both metallurgy and engineering.

The preparation of magnesia from sea water is not new, going back to the early days of the basic Bessemer process, but it is only in very recent years that it has become of real importance. Oceanic water contains about 0·14 per cent of magnesium, and the process is represented by the simple reaction:

$$MgCl_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaCl_2,$$

the relatively insoluble magnesium hydroxide being precipitated. It is, however, often necessary to remove other salts by the addition of lime prior to the recovery of the magnesium, and conditions must be so adjusted that the particles are of such a size as to filter rapidly. By using calcined dolomite instead of lime, the yield is increased.

The earlier methods of reduction of the magnesia by an alkali metal have now only historical interest, but in 1830 Faraday decomposed molten magnesium chloride electrolytically; and in 1852, Bunsen improved this process and thus laid the foundation of that most widely used to-day. There are great advantages in employing a process which yields the anhydrous chloride in one operation; the alternative is to expel water from the hydrated salt, the last two molecules of water in which are retained somewhat firmly, the dehydration then often resulting in the formation of the oxide and oxychloride. This may be effected by taking advantage of the reaction between magnesia, dry chlorine and carbon.

$$MgO + C + Cl_2 \rightarrow MgCl_2 + CO,$$
$$2MgO + C + 2Cl_2 \rightarrow 2MgCl_2 + CO_2.$$

As both these reactions are exothermic, the heat required is not great. The ground magnesia is mixed with carbon in the form of coke or anthracite dust, together with some material, such as sawdust or peat, to make the mass porous, and made into briquettes. Molten magnesium chloride in the anhydrous state is then tapped off from the base of the furnace.

Theoretically, the chlorine process is a cyclic one, the chlorine absorbed in the chlorination plant being again set free in the electrolytic cell. In practice, however, this recovery is by no means complete, a fact which is partly due to the formation of hydrochloric acid with moisture. It is necessary, therefore, both to add chlorine from some other source and to absorb the acid fumes in some sort of washing plant.

Full details of the electrolytic practice are not generally available, but in broad outline this consists of rectangular steel cells with graphite anodes and iron cathodes. The bath of fused salts usually contains chlorides of the alkali or alkali-earth metals in addition to the magnesium chloride, in order to lower the melting point as well as to lessen the decomposition, which is appreciable when the pure salt is kept in the molten state. Fluorides are also sometimes added. On account of the low density of magnesium, it floats on the surface, rendering it necessary to provide for the complete separation of the upper parts of the anode and cathode compartments, in order to prevent contact of the metal and the chlorine produced. The partitions are of ceramic material immersed from above. Large electrodes of good design are also necessary, each cell usually carrying 15–20,000 amp. with a potential difference of 7–9 volts. The bath temperature varies from 670° to 750° C., the energy consumption being about 20 kWh per kgm. of metal. The liquid magnesium is skimmed off from time to time, and with modern casting and remelting technique a very pure metal is obtained free from the inclusions of hygroscopic chlorides to which corrosion was once attributed.

Attempts to manufacture magnesium by processes similar to that used in the extraction of aluminium have so far proved a costly failure in the United States. The solubility of magnesia in molten fluorides is much less than that of alumina in cryolite, and the salt baths have both a higher melting point and density.

Magnesium being a volatile metal boiling at 1097° C., the reduction of the oxide by a non-volatile reducing agent, carbon, calcium carbide, ferro silicon, aluminium, etc., and the removal of the metal in the form of vapour has suggested itself to several inventors. The presence of even a small proportion of oxide, however, prevents the magnesium from forming a homogeneous mass; hence it is necessary to work under conditions approximating to a vacuum. Although on the face of it a simple process, the reduction of magnesia by carbon presents many difficulties. The temperature needed is 2000° C. or more, and the reaction is reversible. As the vapour cools, the oxide tends to reform, and even with an efficient condenser and dilution with an inert gas the dust obtained is contaminated with oxide. Using briquetted materials heated in an arc furnace, and cooling the vapour in a jet of strongly cooled hydrogen, by which means the temperature of the vapour is very quickly reduced to about 200° C., the condensed dust may contain only 90 per cent of the metal. Redistillation is required in an atmosphere of hydrogen or natural gas with the filtration of the oxide particles, followed by direct condensation to the liquid state. It is not surprising that the process has proved difficult to carry out and that serious explosions have occurred.

The substitution of calcium carbide for carbon as the reducing agent eliminates the formation of a gaseous product which can bring about the reverse reaction on cooling. The reaction,

$$MgO + CaC_2 \rightarrow Mg + CaO + 2C,$$

is carried out in vertical gas-fired retorts of heat-resisting steel in which the mixture of magnesia and the carbide is heated. A vacuum is maintained, and the metal condenses in a compact form instead of as dust. Reduction with ferro-silicon occurs at a temperature of 1200–1400° C. and possesses the advantage that calcined dolomite may be employed. This process is being developed on a large scale in the United States, where the ferro-silicon can be produced in electric furnaces in scattered plants having a surplus of hydro-electric power.

A process for the reduction of magnesia by aluminium is an interesting example of the application of laboratory high-vacua technique on a commercial scale. The magnesia, obtained from sea water, is calcined, ground and mixed with aluminium or aluminium alloy. Briquetted under pressure, the mixture is charged into crucibles and pre-heated to about 400° C. The crucibles have a downward central outlet leading to the condenser placed beneath. The self-contained unit consisting of crucible and condenser is raised into an electrically heated vertical cylindrical furnace. The furnace is then sealed and heated to 1100–1250° C. under a pressure of less than 4 mm. of mercury. The magnesium distils over into the water-cooled condenser, in which it solidifies as a mass of crystals of high purity; the mass is readily transferred, on breaking the seal, to the remelting furnace, from which it is cast into ingots. A continuous furnace on the same lines has been designed, and, as aluminium swarf and other reducing agents may be employed, the process possesses great elasticity.

F. C. THOMPSON.

NEWS and VIEWS

Research in the United States

IN a recent statement made by Sir Ernest Simon before the Parliamentary and Scientific Committee, some outstanding facts were given concerning research in the United States. The research unit of the Bell Telephone Company, for example, has some 5,000–6,000 research workers concentrated on the one problem of telephonic communication. In the United States there seemed to be little need to persuade the business man, hard-headed though he be, of the value of research. He is now so firmly convinced by the results of the last twenty years, in peace and in war, of the necessity of research, that expenditure has risen to an astonishing figure, and, during the great depression, the research budget was the last to be cut. In 1940, according to an official report, industry was maintaining some 2,200 laboratories with a research staff of 70,000, at an annual cost of three hundred million dollars. Sir Ernest wondered what the expenditure is in Great Britain; he doubted whether it was £4,000,000, yet it was to be noted that the United States population was only three times greater than ours. Per head he estimated that the United States were spending five times as much as we spend on university and industrial research. The results were significant. America now leads in hydrocarbon research, the world order being now: United States first, Germany second, Russia third and Great Britain fourth. Yet coal is our only special large-scale natural resource, and success in the difficult post-war period in exporting enough to pay for our essential imports will depend to a substantial extent on the most scientific treatment of our coal in order to get from it the maximum value.

This question of research is, of course, broadly divisible into two parts: research conducted by industrial organizations and research conducted by universities, and Sir Ernest Simon had some equally striking points to make concerning American universities. Their size and number is almost startling. When, during 1937–38, we had about 50,000 university students in Britain, America had a million. Their income was £97,000,000, while ours was just over £6,000,000. American grants from Government authorities were ten times, and from private generosity, twenty times as great as ours. In engineering, for example, there were, in the same year, 12,000 graduates from the American schools compared with about 800 in Great Britain. Now none more than ourselves realize that this comparison either of research or of numbers of universities and students may quite easily be very misleading. There are many factors which need close examination before final and valid conclusions can be drawn. The standards of graduate qualification must be closely examined and more particularly the work done by post-graduate students. The same care is needed when comparisons of arrangements for research are made, for research is a word capable of many interpretations. In saying that, we have no intention of attempting to detract from the vast and expert work of American research organizations and of American universities. By whatever test which may be applied it seems clear, from the points made by Sir Ernest Simon, that America has set and is setting an example which ought, without any avoidable loss of time, to be followed in Britain. The discussion which followed Sir Ernest's statement showed how the problem was appreciated by his listeners and gave indications of where research here should be encouraged and fostered.

Carnegie Trust for the Universities of Scotland

THE forty-first annual report of the executive committee of the Carnegie Trust for the Universities of Scotland (Edinburgh: Carnegie Trust for the Universities of Scotland) covers the year 1941–42. The method of interim distribution begun in the academic year 1940–41 was again employed, the annual grants being subjected to a 10 per cent deduction to safeguard the position at the close of hostilities. It has now been arranged that application for grants for research may be made at any time during the year and will be considered by the Executive Committee at such times as may be found convenient. With regard to assistance to students, there was a decrease of 184 beneficiaries in 1941–42 as against 1940–41, the fall being almost wholly among male students, and the decrease was greatest in the faculty of arts; in the faculty of medicine there has been an increase, whereas in the faculty of science the figures have remained relatively steady. The year has been noticeable for the number of repayments made by Scottish graduates now abroad. Appendixes include a report upon the work of investigators under the research scheme during the academic year 1941–42, in which reference is made to work on the synthesis of methyl-glucoses and related studies, the attempted synthesis of a bis-isoquinoline derivative with a structure related to that of emetine, to work on the chemistry of penicillin, investigations on the eel-worm disease of potatoes, the reliability of mental tests, and to Dr. A. P. Hickie's work under Dr. W. O. Kermack at the Royal College of Physicians' Laboratory, Edinburgh, on the preparation of pyridoquinoline compounds with a constitutional relation to compounds of known anti-malarial activity.

Further reference to this work is made in the report of the superintendent of the laboratory of the Royal College of Physicians for the academic year 1941–42, which is also appended. Research in the Chemical Department under Dr. Kermack's supervision has been mainly in this field of synthetic anti-malarials. The synthesis of new *m*-phenanthrolines has now been taken up by Dr. W. Tebrich, and work on *o*-phenanthroline derivatives has also been continued and the nitration of 4-chloro-2-methylquinoline has been examined. Good progress has been made in work on the synthesis of derivatives of the complex ring system pyridoacridine, and the preliminary account of Dr. Tebrich's investigations jointly with Dr. J. M. Robson on the penetration of albucid soluble into the ocular tissues of rabbits following local application has already appeared in NATURE (**148**, 167; 1941). In the Department of Histology, studies of breast cancer have been continued, as well as an intensive study of a remarkable case of generalized sarcoidosis; and in the Bacteriological Laboratory the search for a basic medium for the cultivation of bacteria has been continued. Lists of publications by fellows, scholars and recipients of grants received since September 30, 1941, and of publications by teaching fellows are also appended to the report, with details of assistance to students and the abstract of accounts for the year ended September 30, 1942.

Sir John Floyer (1649–1734)

A PAPER on "Sir John Floyer and his Times" was read recently before the Johnson Society by Mrs. Lilian Lindsay, honorary librarian of the British Dental Association. Sir John Floyer was born in 1649 at Lichfield, the birthplace of Samuel Johnson, and was educated at Queen's College, Oxford, where he took his M.B. in 1674 and his M.D. in 1686. The course consisted in readings in the medical classics and memorizing the aphorisms of Hippocrates and the works of Galen. Theses were written and were upheld in disputation. There was no clinical teaching or opportunity for practical experience. The more serious students went abroad for this, especially to Padua. In 1686 Floyer was knighted. In 1687 appeared his first book entitled "The Touchstone of Medicines Discovering the Vertues of Vegetables, Minerals and Animals by their Tastes and Smells", which was published by Dr. Johnson's father, in the preface to which he mentions that he had visited the Garden which the Society of Apothecaries had brought in 1671 and was first called the Physic Garden in 1678. In 1697 he published an inquiry into "The Right Uses and Abuses of Hot, Cold and Temperate Baths in England", which contained a history of bathing from the earliest times and showed that Floyer had visited all the available springs, wells and watering places in Great Britain.

Floyer's chief contribution to medicine, however, was his work on "The Pulse Watch" (1707), in which he related how for many years he tested healthy pulses among his patients by pendulum clocks and common watches until he found a minute glass which he used in his experiments on cold bathing. His "Treatise on Asthma", of which the first edition was published in 1698 and the third in 1745, gave the first description of pulmonary emphysema in asthma, from which he suffered himself. In 1725 appeared his "Medicina Gerocomica, or Galenic Art of Preserving Old Men's Health", in which he advocated fresh air, exercise, regular diet and temperance in all things, especially alcohol and tobacco. Two of his contributions were read before the Royal Society, one on the dissection of a monstrous pig and the other on the sweet taste of plants. In conclusion, Mrs. Lindsay remarked that Floyer resembled John Hunter in his passion for experiment but lacked his genius in interpretation and orderly thinking.

Earthquakes Registered in New Zealand

DURING January 1943 only four distant earthquakes were registered by the seismographs at Auckland, Arapuni, Christchurch and Wellington, New Zealand, according to the provisional bulletin just received (Provisional Bulletin No. P–131, New Zealand Seis. Rep., Dominion Observatory, Wellington, N.Z., Jan. 1943). The first earthquake was on January 2. *P* waves were received at Auckland at 19h. 32m. 20s. U.T. from an epicentre 22° distant. The second, on January 9, came from an epicentre some 25° from Wellington, *P* waves arriving at this place at 02h. 20m. 01s. U.T. The third shock was on January 27, possible *P* waves arriving at Wellington at 02h. 58m. 30s. U.T. from an epicentre 95° distant, though interpretation of this record was difficult owing to the small amplitudes being confused by microseisms. The last shock of the month, the epicentre of which was at a greater distance than 10° from Wellington, occurred on January 30. *P* waves were received at Christchurch at 06h. 05m. 40s. U.T. from an epicentre some 53 km. distant. During the month there were in addition twenty-five earthquakes the epicentres of which were at a distance less than 10° from Wellington. All but four of these were felt at some place or other in New Zealand; two were felt at Wellington, three at Masterton, and six at Wairoa. The greatest felt, reckoned on the modified Mercalli scale, was on January 24, about Foveaux Strait, where the intensity reached scale V. Greater instrumental magnitudes occurred on January 4 and January 9, though the former only attained modified Mercalli scale III at Ohakune and Taihape, and the latter, from an epicentre some 200 km. distant, was apparently not felt in New Zealand.

Earthquakes Registered in Spain

DURING the month of March 1943, thirty earthquakes were registered by the seismographs at the Observatory at Toledo (Registro de las observaciones provisionales correspondientes al mes de Marzo de 1943, Observatorio Geofisico de Toledo). Twelve of these were sufficiently strong and well registered as to have their epicentral distances determined, and two further shocks had their epicentral distances provisionally determined. The largest shock of the month to be recorded was on March 9. This began with *ePz* at 10h. 02m. 59s. from an epicentre some 11,180 km. distant and attained a maximum ground amplitude at Toledo of 74 μ at 10h. 45m. 47s. The second strongest shock of the month to be recorded was on March 21, which began with *iPz* at 20h. 55m. 09s. and attained a maximum amplitude of 29 μ at 21h. 56m. 23s. The epicentre was 16,000 km. from Toledo. Two shocks, apparently from the same epicentre 9,500 km. from Toledo, had a depth of focus of approximately 120 km. These were on March 14 and 15. The only 'near' earthquake of the month was apparently on March 26. The epicentre was 560 km. from Toledo and the focus was 25 km. deep, but as the azimuth was not determined, other observations are required before the epicentre can be accurately determined.

Invention of the Barometer

THE tercentenary of the invention of the barometer will be marked by a meeting, to be held at the University of Toronto on October 19, arranged by a committee including representatives of the Royal Meteorological Society (Canadian Branch), Royal Astronomical Society of Canada, Royal Canadian Institute and the University of Toronto. Papers will be presented by Prof. L. C. Karpinski on "Telescope, Microscope, and Barometer as a Point of Departure for the Natural Sciences"; Prof. G. S. Brett on "The Effects of the Discovery of the Barometer on Contemporary Thought"; W. E. Knowles Middleton on "Subsequent History of the Barometer"; and Prof. John Satterly on "The Applications of the Barometer in Physics and Chemistry". Correspondence should be addressed to the secretary of the Committee, A. D. Thiessen, 315 Bloor Street West, Toronto, Canada.

Epidemiology of Leprosy

ACCORDING to a paper on this subject by Dr. G. W. McCoy, medical director (retired) of the United States Public Health Service (*Public Health Rep.*, Dec. 18), leprosy tends to disappear from many parts of the world, while in other parts it tends to spread freely. At the present time in Europe the disease spreads apparently only in the countries bordering on the Mediterranean and the Baltic. As regards the United States, in Louisiana, Florida and Texas the presence of imported cases from the British West Indies, Dutch Guiana, South America, China and Chile, has resulted in the establishment of foci in which the disease shows a strong tendency to perpetuate itself, while in the central north-western States, such as Minnesota, leprosy has shown little tendency to become established. In other parts of the United States the disease is so rare as to be practically negligible from the public health aspect. Dr. McCoy concludes that in an age in which great social and economic changes are occurring, it is impossible to predict what effect they may have on leprosy or other diseases.

Deaths from Exposure to Cold

ACCORDING to an editorial in the January issue of the *Statistical Bulletin* of New York, during the eight-year period for which data are available, namely, 1933–41, the deaths in the United States from exposure to excessive cold—freezing, frostbite, etc.—were on the average 363 annually or about 3 per 1,000,000 persons. The highest figure (579) was reached in 1936 when there was exceptionally cold weather over a large part of the country, while the minimum figure of 190 in the period was in 1939. In the United States as a whole, males were the victims of exposure to excessive cold about four times as frequently as females, and two thirds of the male deaths occurred in men of fifty and more, many of whom were probably suffering from arterial diseases and therefore more susceptible to the effects of exposure. The highest rates in the country were found in the mountain States of Nevada, Montana, and Wyoming, while the district of Columbia was lowest and California came next.

Announcements

DR. W. G. OGG, director of the Macaulay Institute for Soil Research, Aberdeen, has been appointed to succeed Sir John Russell as director of the Rothamsted Experimental Station on Sir John Russell's retirement at the end of September.

SIR LAWRENCE BRAGG, Cavendish professor of experimental physics in the University of Cambridge, and Prof. C. G. Douglas, professor of general metabolism in the University of Oxford, have joined the Council of the Gas Research Board.

DR. E. W. SMITH, president-elect of the Institute of Fuel, has been awarded the Birmingham medal of the Institution of Gas Engineers, in acknowledgment of his outstanding work during the past thirty years for the gas industry. The Birmingham medal was founded some sixty years ago, and has only been presented on fourteen previous occasions during that period.

MR. R. W. PAUL, who died on March 28 (see NATURE, April 24, p. 470), has left the proceeds from the sale of his shares in Cambridge Instrument Company (to be called the R. W. Paul Instrument Fund) to be used for the design, construction and maintenance of novel or unusual instruments for investigation in physical science, and subject thereto to the Royal Institution, the Physical Society and the Royal Society; and on his wife's decease £5,000 to the research fund of the Royal Institution of Great Britain, and £500 each to the Benevolent Fund of the Institute of Physics, the Cinematograph Trade Benevolent Fund, and the Benevolent Fund of the Institution of Electrical Engineers.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Quantitative Theory of the Precipitin Reaction

THE theory which follows is, in the main, based on the same fundamental ideas as have recently been employed by several authors[1,2,3,4]. The mathematical treatment, it is believed, is more simple than that of Heidelberger and Kendall, and the results seem to have a more general significance. The principle applied is the same as that governing the dissociation of a weak polybasic acid of the type $H_N^+X^-$, namely, that of 'step dissociation'. The antibody A (corresponding to the hydrogen, H) is assumed to be *uni*valent and combines in steps with the *poly*valent antigen G (corresponding to the X ion of the acid with the valency N) to form compounds AG, A_2G . . . to A_NG. All these compounds exist simultaneously, their relative quantities being dependent on the total concentration of G, the concentration of 'free' A and the equilibrium constants k_1, k_2 . . . to k_N, exactly as the proportions of the various anions of the acid H_NX are governed by its total concentration, the hydrogen ion concentration and the N dissociation constants. The simultaneous equilibria are

$$
\begin{array}{ll}
A + G \rightleftarrows AG & \text{(equil. constant } k_N) \\
A + AG \rightleftarrows A_2G & \text{(equil. constant } k_{N-1}) \\
\cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\
A + A_{N-1}G \rightleftarrows A_NG & \text{(equil. constant } k_1).
\end{array}
$$

It is now assumed that several or all A–G compounds very soon become insoluble. Therefore a necessary condition of the theory is that the final flocculation takes place in such a manner that it does not disturb the equilibria already established. In order to explain the 'inhibition' or the 'post zone', in agreement with Heidelberger and Kendall and others, it is believed that the A–G compounds richest in G (AG and possibly A_2G) will retain a more or less complete solubility. Accordingly, the total precipitate formed will consist of a mixture of the insoluble A–G compounds. These are calculated by aid of the mass-action law which, for the simplest compound AG, gives

$$[AG] = \frac{[A]}{k_N} \cdot [G].$$

By proper substitution the following general expression may be derived for any compound A_nG

$$[A_nG] = \frac{[A]^n}{k_N \cdot k_{N-1} \cdot k_{N-2} \cdot \ldots \cdot k_{N-n+1}} \cdot [G] \,.\ (1)$$

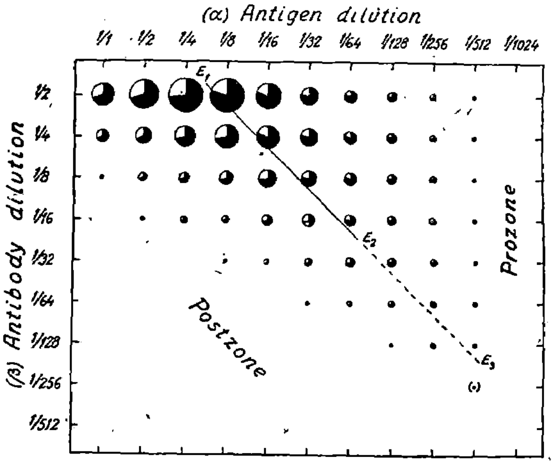
Furthermore, the known total molar concentrations of the antibody $[a]$ and the antigen $[g]$ may be written

$$[a] = [A] + \sum_{n=1}^{n=N} n[A_nG] \quad . \ . \ . \ . \ . \ (2)$$

$$[g] = [G] + \sum_{n=1}^{n=N} [A_nG] \quad . \ . \ . \ . \ . \ (3)$$

The N equations of type (1) together with (2) and (3) supply the $(N+2)$ equations necessary to enable a complete solution for the unknown quantities $[A_NG]$ . . . $[AG]$, $[A]$ and $[G]$ in terms of the known mixed quantities of antibody $[a]$ and antigen $[g]$ and the known dissociation constants k_1, k_2 . . . k_N. The numerical solution is best performed by an interpolation method. This may be somewhat tedious and consists in a successive variation of the 'free' antibody concentration $[A]$ and calculation of the corresponding $[G]$ and $[a]$ or $[g]$, depending upon whether the antibody or the antigen concentration is regarded as fixed and the antigen or the antibody concentration as a variable (corresponding to the 'antigen dilution' and the 'antibody dilution' procedure of immunological practice; compare the α- and β-procedure of Marrack).

A graphical representation of some consequences of the theory is given in the diagram.



The diagram pictures on a true scale a precipitin reaction of a 'quadrivalent' antigen ($N=4$) with inhibition due to complete solubility of the compound AG. Horizontal rows represent α-procedures with the antibody quantity constant, vertical rows denote β-procedures with the antigen quantity constant. The areas of the circles are proportionate to the weight of the precipitates. Precipitates amounting to less than 1 per cent of the largest pictured are not plotted. The black and the white sectors represent antibody and antigen respectively. The following parameters were employed: the dissociation constants were chosen to fit in a 'statistical' order $k_1 : k_2 : k_3 : k_4 = 1{\cdot}6 : 0{\cdot}60 : 0{\cdot}27 : 0{\cdot}10$; the dilution 1 : 1 corresponds to 1,000 concentration units and the molecular weights of A and G are both taken as unity.

The theoretical results are in good agreement with the experimental facts (cf. Marrack, *loc. cit.*, Fig. 23, p. 157). In an antigen dilution procedure, for example, antigen in great excess causes little or no precipitation ('postzone' or 'inhibition zone'); as the amount of antigen is reduced the amount of precipitate rises to a maximum and gradually falls again to zero ('prozone'); as the amount of antigen is reduced the amount of precipitate rises to a maximum and gradually falls again to zero ('prozone'). The characteristic variation of the ratio A to G in the precipitates is also in accordance with many experimental observations (cf. Marrack, *loc. cit.*, Table 24, p. 161). In the special case shown in the diagram, the 'equivalence points' or 'neutral points' (lying in the middle of the zone in which neither antibody nor antigen, or traces thereof, appear in the supernatant fluid, situated on the line $E_1 - E_2$ in the diagram) very nearly coincide with the maximal precipitations. At the lower A and G dilutions the equivalence precipitation becomes increasingly incomplete (the line $E_2 - E_3$). In other cases, however, particularly in the absence of inhibition due to soluble AG, it can be shown that the equivalence point in a dilution series may appear long before a maximum amount of precipitate is attained (compare, for example, the albumin anti-albumin systems of Taylor, Adair and Adair[5]).

A detailed account of the proposed theory and its application to the antigen-antibody reactions in general will be published elsewhere.

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April 20.
TORSTEN TEORELL.

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[1] Heidelberger, M., and Kendall, F. E., *J. Exp. Med.*, **61**, 559 (1935).

[2] Marrack, J. R., "The Chemistry of Antigens and Antibodies" (London, 1938).

[3] Haurowitz, F., "Fortschr. d. Allergielehre" (Ed. by P. Kallós), p. 19–71 (Basle, 1939).

[4] Pauling, L., *J. Amer. Chem. Soc.*, **62**, 2643 (1940).

[5] Taylor, G. L., Adair, G. S., and Adair, M. E., *J. Hyg.*, **34**, 118 (1934).

A Variant of Maxwell's Experiment on the Movement of Magnets about a Straight Conductor

THE experiment described by Maxwell[1] in which magnets are placed on a tray free to rotate about a long straight wire carrying a heavy current is well known. The present variant of this experiment is intented for demonstration purposes, and provides for (*a*) a proof that the forces acting on the magnets are amply large enough to cause a violent movement of the tray if the resulting moment was not in fact zero; (*b*) the use of current-carrying coils as well as magnets.

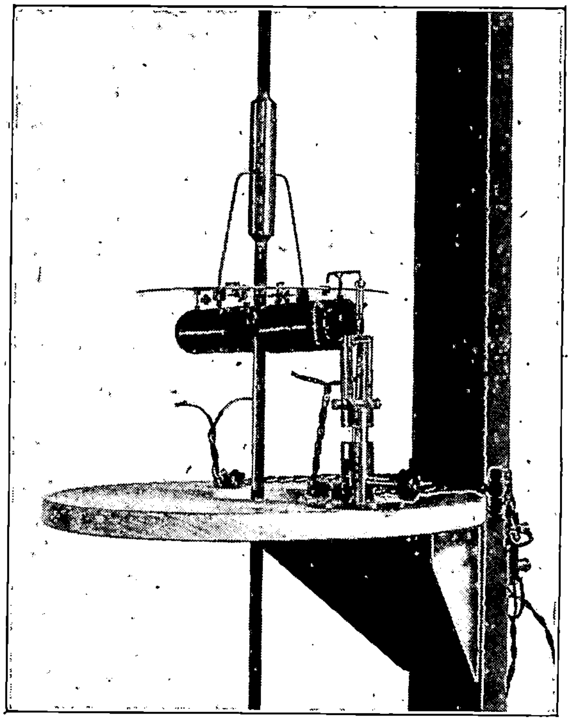
A light metal tray 6 in. in diameter is attached to two arms fixed rigidly to the centre support, which has a hard steel pivot let into each end, these pivots being supported between two jewelled screws carried in a special housing of brass which is made in two halves so as to enable the tray to be pivoted along the axis of the long straight conductor, slots being cut in the housing to allow a rotation of the tray through about 90°. The conductor rod is then screwed into the ends of this housing, and the result is a fairly rigid tray free to move easily about the axis of the conductor. The tray is arranged to carry either the two small magnets or two coils, or both magnets and coils.

When using the magnets, as in the original experiment, one of them rests on small v-guides and the other on a pivot on the inside and a guide on the outside. The latter magnet has also at its outer end a free pivot arranged so that a lifting device standing on a fixed table can be brought up, and the weight of the outer end of this magnet is thus no longer transmitted to the tray. Under these conditions the tray moves vigorously in a direction depending upon the direction of the current in the conductor, the direction of movement being reversed when the current is reversed.

The experiment with the coils is similar. Each coil has 330 turns of No. 30 S.W.G. enamel insulated wire wound in two layers, on a fibre tube $2\frac{13}{16}$ in. long and $1\frac{1}{8}$ in. diameter, and is suspended from the tray by small brass hooks, one hook being extended so as to provide a means of lifting one pole. The current is supplied to the coils by means of No. 40 S.W.G. copper wire with tiny connectors which clip on to rigid conductors under the coils, these conductors being twisted together so that their magnetic field does not affect that due to the current in the straight rod.

When the coils are energized and rest wholly on the tray, there is no movement when large currents are reversed in the vertical wire. But if one end is lifted, the tray is strongly deflected to right or left when the current in the wire is flowing, showing that the forces acting are large enough to be observed, unless the resultant moment about the vertical wire is zero.

The lifting device is raised by means of an eccentric and carries an arm pivoted horizontally so as to allow a movement at right angles to the conductor rod as the tray rotates.



The whole is mounted on a wooden frame provided with levelling screws. The photograph shows the coils on the tray and the lifting device at the side.

A current of about 100 amperes is used in the straight conductor and 1–1·5 amperes in the coils.

The significance of this experiment is interesting. Neither the coils nor the magnets are small compared to the distances from the central current-carrying conductor. No precautions are taken to secure exact symmetry in the magnetization of the magnets, and the current-carrying coils themselves are not symmetrical. Although the supports of the magnets and coils are actually fixed in the apparatus as made, the position of the coils and magnets relative to one another makes no difference to the experiment. This variation of the original experiment seems, therefore, to establish the following points : (1) Any magnet, however magnetized, must be regarded as being equivalent to a system of small magnets having the properties of the ideal 'magnetic particle'. (2) A current-carrying coil must be exactly equivalent to a system of ideal 'magnetic particles'. (3) The deductions with regard to the field of a long straight current-carrying wire as usually given.

The apparatus was constructed at the instigation of Prof. C. L. Fortescue for demonstrations to students of the Electrical Engineering Department of the Imperial College (City and Guilds College).

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[1] See "Electricity and Magnetism", vol. 2, Art. 477.

Production of Ion Clusters by X-Rays

ACCORDING to recent work[1], X-ray-induced chromatid breaks in Tradescantia microspores are due to the simultaneous occurrence of about seventeen ionizations concentrated within the narrow section of a chromatid. Such clusters of ionizations can be produced by electrons with small kinetic energy, that is, by electrons approaching the end of their path through matter. It might be of interest, then, to determine how many clusters consisting of a given number of ionizations (n) are produced per unit volume and per roentgen; or, which is equivalent, what fraction of all ionizations is concentrated in such clusters. For the sake of simplicity, a 'cluster' will be arbitrarily assumed to consist of the last n ionizations produced by an electron at the end of its path. Accordingly, there will be as many clusters as there are electrons producing at least n ionizations along their entire path. Also for simplicity, the following calculation will be restricted to cases in which the number n is greater than 2 or 3, but is still so small that many clusters result from every photo- or Compton-electron released by X-rays.

Consider one photo- or Compton-electron A, the kinetic energy T of which is much greater than the energy, $E_n = n\varepsilon$, necessary to produce n ionizations ($\varepsilon \sim 32$ ev.). The number of secondary electrons (δ-rays) with kinetic energy between E and $E + dE$, which are in turn released by A per unit length of its path, is approximately[2] $(\pi e^4 NZ/T)(dE/E^2)$, where e is the electron charge and N the number of atoms of atomic number Z per unit volume. (It is assumed here that E is much greater than the binding energy of atomic electrons, an assumption that may not be accurately fulfilled so far as the K electrons of atoms like carbon, nitrogen, or oxygen are concerned.) The number of clusters per unit path will then be approximately:

$(\pi e^4 NZ/T) \int_{E_n}^{\infty} dE/E^2 = (\pi e^4 NZ/T)(1/E_n)$. Consequently, the energy contributed by the electron A per unit path to the actual production of clusters is about $\pi e^4 NZ/T$. On the other hand, the total energy lost by A per unit path is given approximately by Bloch's formula[3] $2(\pi e^4 NZ/T) log(T/B_Z)$, where the energy $B_Z = 11{\cdot}2$ ev. is an average value of the binding energy of the atomic electrons. Therefore the fraction (f) of the radiation energy actually used in producing clusters, that is, the fraction of all ionizations concentrated in clusters, will be:

$$f \sim 1/2 log(T/B_Z). \qquad (1).$$

This fraction is one of the quantities characterizing the physical action of X-rays, which are approximately independent of the velocity of the photo- or Compton-electrons and hence of the X-ray wavelength. This same fraction is also independent of the number n. When formula (1) is applied to tissues of living organisms, the presence of elements with different values of Z in their chemical constitution must be taken into account. When $T = 10^5$ ev., evaluation of the formula for hydrogen and oxygen yields 1/18 and 1/14 respectively; $f \sim 1/15$ is probably a fair estimate of the result for tissue. Since 1 roentgen of X-rays produces approximately $1{\cdot}7$ ionizations per μ^3 tissue, it will also produce about $1{\cdot}7\ f/n \sim 1/10n$ clusters per μ^3.

Because of the simplifications involved in the above calculation, its results may be regarded only as an indication of order of magnitude. The purpose was mainly to present a basically simple method, which might easily be improved upon to fit the requirements of specific applications. One rough verification will be carried out here. According to Lea and Catcheside[1], the total volume of the chromatids in a *Tradescantia bracteata* microspore is $7{\cdot}6\ \mu^3$, and one chromatid break, on the average, is produced by 20 r. X-rays. Hence one break is associated, on the average, with the production of $\sim 20 \times 7{\cdot}6/10n = 15/n$ clusters in the chromatids. A one-to-one correspondence of clusters and breaks may thus be obtained by taking the value $n \sim 17$ found by Lea and Catcheside. This numerical coincidence must be regarded as partly accidental, but gives support to the conclusion that chromatid breakage requires a substantial number of ionizations occurring at a single time and place.

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April 28.

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[1] Lea, D. E., and Catcheside, D. G., *J. Genetics*, **44**, 216 (1942).

[2] Bohr, N., *Phil. Mag.*, **30**, 606 (1916).

[3] Bloch, F., *Z. Physik*, **81**, 363 (1933).

Relation of Hypopituitarism and Starvation

ACCORDING to an estimate recently made here, there are now about 400,000,000 people in the world suffering from malnutrition. Whatever the true figures, it is apparent that a problem of appalling dimensions exists—one which is becoming increasingly a United Nations problem, and which the collapse of the enemy would throw entirely upon our hands. Assuming the best possible management of food supplies and vitamins, one wonders whether this will be enough. One also wonders whether there may not be some overlooked weapon which can be brought to bear against hunger.

After the siege of Kut in the War of 1914–18, it took the survivors, who had been on half rations for five months, from a year and a half to two years to regain their body weight and their ability to eat normal amounts of food. This great depth and persistence of effect of chronic malnutrition can be understood, I think, only in the light of some recently acquired knowledge of the endocrines. Sir Patrick Hehir during that siege observed that sometimes emaciated but otherwise unharmed soldiers were found dead in their bunks. It is likely that they died of hypopituitary cachexia.

That malnutrition affects the endocrine organs is well known. C. M. Jackson in 1925 assembled considerable evidence that, in general, chronic inanition leads to endocrine atrophy. More recently, it has been shown that in several laboratory animals this general endocrine failure is due primarily to the inability of the anterior pituitary to send out its 'tropic' hormones. These effects of chronic malnutrition in laboratory animals have been designated as the *pseudo-hypophysectomy syndrome* by Mulinos and Pomerantz: "not only because of the resemblance between the effects of inanition and hypophysectomy but also because we believe that many of the effects of inanition are due to malnutrition of the hypophysis, resulting in a diminished secretion of hormones". The clinical analogue of this syndrome, perhaps, is found in the human disease *anorexia nervosa* (D. J. Stephens, 1941).

If this interpretation is correct (and there are many more facts to support it), then millions of people are suffering not only from starvation but also from hypopituitarism of varying degree *and kind*. Treatment of these people with hormones, supplementary to adequate diet, may well result in more rapid and complete recovery. This in turn would enable relief workers to extend their operations more rapidly, ultimately reaching more of the victims than could otherwise have been helped. Hormone treatment may be especially important for children, not only to save their lives but also to prevent stunting and dystrophic growth. Luckily, we probably should not be limited to any one hormone, since the types of endocrine failure encountered will not all be the same, and since growth and protein-economizing properties are manifested by several hormones. Synthetic hormones such as testosterone and desoxycorticosterone acetate may be found useful. Chorionic gonadotropin and sex hormones, as well as a number of pituitary extracts, have been used clinically with marked success in stimulating growth in retarded children.

At present the greatest need is for more knowledge upon the long-term effects of malnutrition, and of the period of recovery from inanition. The use of pseudo-hypophysectomized animals, some treated with hormones, can bring us much of this knowledge within a year. Cautious therapy in undernourished human beings would also be justified. The biologists and physicians of the United Nations should obtain the needed information and see that it is used.

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Studia Moritura

THIS War has naturally set back research work in all save a few subjects. There is, however, no reason for supposing that a subject which is normally studied by a comparatively large number of people will suffer any permanent setback. Thus research on subjects such as the Vulgate text, Middle English philology or the theory of numbers will presumably again be in a flourishing state quite soon after the end of the War.

There are nevertheless a few subjects which may well be destroyed as a consequence of the War. It seems desirable that attention should be directed to such subjects now, lest even the fact that they once existed should escape notice in the future.

Finno-Ugrian philology affords an excellent example. The Finno-Ugrian group comprises four well-known languages (Finnish, Hungarian, Estonian and Lappish) and a number of lesser-known languages in the U.S.S.R. (for example, Mordvin); the Samoyede languages are distantly related. Finno-Ugrian philology has naturally always been most studied in those countries where the national language is a Finno-Ugrian one, namely, Finland, Estonia and Hungary. During the last few years before the War it was, however, only studied with real intensiveness in Finland. Finland had, in Helsinki, the Finno-Ugrian Society with its magnificent lexicographic archives of all the lesser-known Finno-Ugrian languages; these collections, going back to the beginning of the century, were for the most part still in manuscript but were in gradual course of publication. Some fifteen miles outside Helsinki, the Suomen Suku Institute, a State-sponsored research institute, had as one of its main objects the gradual compilation of a complete etymological dictionary of all the Finno-Ugrian languages. (It was hoped to complete this in about fifty years.) The University of Helsinki devoted much care to the fostering of Finno-Ugrian studies—in particular to ensuring that each of the lesser-known Finno-Ugrian languages had a specialist, and that this specialist should train a successor. There was a considerable number of young and promising students.

Estonia closely followed the model of Finland. In Tartu there were valuable Finno-Ugrian archives and the University regarded the subject as of great importance. But the smallness of the Estonian nation militated against the existence of any large body of Finno-Ugrists.

In Hungary, where we should have expected the most active interest in these studies, there was of recent years a tendency towards nationalist propaganda and anti-Semitism which on one hand lowered the standard and on the other markedly depleted the body of specialists.

The classical theory of Finno-Ugrian philology has never been a subject of study in the U.S.S.R. Nevertheless, the Russians were doing field-work of the most valuable kind—making large dictionaries and excellent grammars of all the Finno-Ugrian (and Samoyede) languages within their territories.

Outside the countries mentioned there were only isolated individuals engaged in these studies, namely, one in Uppsala, one in Oslo (both specialists of great eminence), one in Paris, one in Germany. Most unfortunately the subject was not studied in the United States, and this despite the large Finnish and Hungarian colonies there. It must be remembered that the would-be student of the subject is much handicapped by the fact that its technical literature is very largely in Finnish, Hungarian or Estonian, languages known to few non-natives.

If the classical study of Finno-Ugrian philology were to become extinct, the loss to philology as a whole would be grave. Of the many language-groups of the world only six have even the rudiments of a sound comparative philology—Indo-European, Semitic, Turkish, Indonesian, Bantu and Finno-Ugrian. Finno-Ugrian philology had made rapid advances; the phonology of the stressed syllables was almost complete; that of the unstressed syllables, the morphology and the many loan-word problems were being vigorously attacked. This group of languages offers many points of wide philological interest; to mention only two: the existence of the most complex ablaut-system known (in Lappish) and the valuable evidence for the earliest Indo-European history afforded by the loan-words of Finno-Ugrian and Samoyede.

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May 15.

Illustration by Analogy

AT the recent British Association conference more attention was given to agencies (Press, B.B.C., etc.) for 'getting science across' to the ordinary citizen than to the mental technique. An outstanding technique is illustration by analogy (Jeans and Eddington in theoretical physics and the late Alfred Marshall and recently Miss Scott in economics). Instances are afforded by the likening of an atom (or electron) to a railway system, solar system and organism (de Broglie), of economic elasticity to mechanical elasticity, of economic laws to tidal law in an estuary, and of the bankers' loan and reserve system to the cyclic juggling of five oranges with both hands. Such comparisons are often effective and exact; but it is desirable that the authors, in writing, and the reader, in reading, should be clear as to what precisely is being asserted and should not fall into the intuitive trap of assuming either too much or too little.

The results of my recent work on analogy in science and language seem particularly relevant in the above connexion and possibly useful as a guide. It can be shown that all analogy is, or may be regarded as, the outcome of diverse things interacting to produce the same or similar effect or result, the result being a single property (if the *reactants*, or *analogues*, have common properties these will be connected with producing the effect); (2) analogy is the source of all substitutes and substituting. It is (2) which is especially relevant to illustration by analogy.

It will be best to take as illustrations 'analogies' somewhat simpler than those referred to above. A well-known elementary *illustrative* analogy in physics is that between a 'one-way' hydraulic system and a 'one-way' dynamo-generator current system. The operational *effect* of the two valves in the pump is identical with that of the divided ring of the commutator. A *scientific* analogy is the 'displacement' produced by the action of mechanical force on a spiral spring and of electric force on a dielectric or conductor. Another with different logical properties is the effect of strychnine on a rabbit and mercuric chloride on a man.

In all three cases we are able to illustrate the same *effect* or action by substituting one set for another. All that one does in 'popularizing' science is to choose the more familiar. It will be noted that the analogous sets or systems themselves differ in respect of substitution or rather partial substitution. The valves cannot be substituted for the commutator, but the strychnine can be substituted for the mercuric chloride at least if the maximum ultimate effect is required; so also can the rabbit and man (without interchanging the poisons).

It should be noted that logically scientific analogies, similes and parables are indistinguishable, and both may be equally true. The difference lies in the importance of the identities to the science or sciences concerned, which *partly* depends on their not being fortuitous and on their being 'exact', especially mathematically. (*Use* is the chief factor.)

When we view two analogous sets or empirical systems statically or 'structurally' we may write:

$$\begin{array}{c} \lambda\ (\alpha \longrightarrow 3) \\ x_1 \ldots . x_n \quad y_1 \ldots . y_n \end{array}$$

(or $x_1 \rightarrow x_2 \rightarrow \ldots . x_n$, $y_1 \rightarrow y_2 \rightarrow \ldots . y_n$ if homologous series).

For the dynamic or operational view, we may write for two reactants:

$$\begin{array}{l} (x_1)\ x_2 \ldots . x_n \searrow\ E \\ (y_1)\ y_2 \ldots . x_n \nearrow \equiv \lambda \end{array} \quad \text{or} \quad \begin{array}{l} (x_1)\ x_2 \searrow\ \ E \\ (y_1)\ y_2 \nearrow \equiv \lambda \end{array}$$

(as in the case of simple isomorphy in the theory of groups). The differences between the x's (and between the y's) vary according to the nature of the sets or systems.

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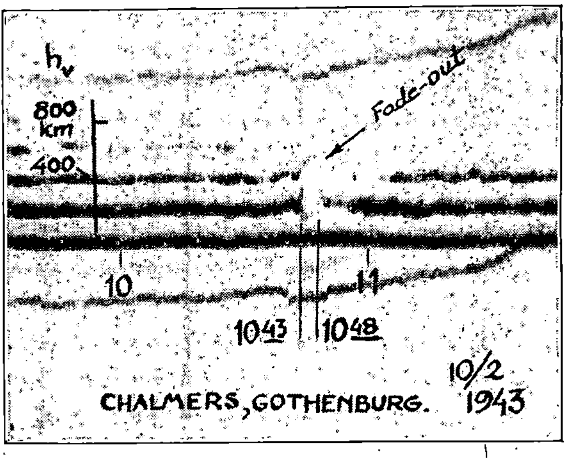
April 28.

Radio Fade-Out in Sweden

ON February 10, 1943, the Prague Observatory reported strong, brilliant sunspot eruptions. On the same day, the Chalmers Ionospheric Observatory registered a radio fade-out between 10.43 and 10.48 local time as shown by the recording. The frequency used was 2·93 Mp./s. It is interesting to note that an oblique incidence double pulse (from a distant sender) was recorded at the same time, as shown by the lowest pattern. During the fade-out, starting and ending before and after it, the recorded double pulse was apparently reflected from the region of abnormal ionization below the regularly reflecting layer. Finally, it should be remarked that the magnetograms showed no conspicuous change at the time of the fade-out.



In order to find out whether the fade-out had any connexion with the sunspots or not, the Chalmers Observatory would like to receive observations from other observatories in the sun-lit hemisphere.

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RESEARCH ITEMS

Natives of Bolivia and Western Matto Grosso

Eastern Bolivia was the mythical *tierra rica* or *eldorado* of which the Spanish explorers dreamed. Alfred Métraux has given, in 170 pages, an account of the little-known native peoples of this part of the world (Bur. Amer. Ethnol., Smithsonian Inst., Bull. 134). The various tribes are considered separately, and an account given in respect to their boundaries, history, manner of life, language, religion, etc. Anyone interested in South America and the still little-known populations of the remote interior of the sub-continent will welcome this volume, which brings together for the first time much scattered material not always very easy to consult.

Distribution and Origin of British Lepidoptera

Under the foregoing title, B. P. Beirne attempt to throw light on the origins and reasons for the present distribution of Lepidoptera occurring in the British Isles. This order of insects is well suited for a study of this kind because the local distribution of the majority of the species commonly known as "Macrolepidoptera" is fairly accurately known in Great Britain, in Ireland and on the Continent. In fact, their distribution is known better than that of most groups of animals. Both in Great Britain and in Ireland, Lepidoptera fall into two groups. (1) Those in which the species have a local or discontinuous range; many of them exhibit local racial variation. (2) Those in which the species have a wide continuous distribution with little or no racial variation. It is concluded that the two groups represent two waves of immigration into the country. Species with a wide and continuous range were probably post-glacial in their time of arrival, while those with a local or discontinuous range came in during the late-glacial Zone II period and were confined in their distribution by the mountain glaciation of the Zone III period. The various points for and against this theory are discussed and the paper is published in *Proceedings of the Royal Irish Academy*, **49**, Section B, No. 2, 1943, and can be purchased separately (price 2*s*.) from Hodges, Figgis and Co., Dublin, and Williams and Norgate, London.

Role of Blue-Green Algæ in Nitre Formation in Deserts

A working hypothesis that the formation of nitre in the desert may be due to the fixation of atmospheric nitrogen by bacteria of the Azotobacter type has been tested by S. V. Odintzova in the high desert of the Western Pamirs (*C.R. Acad. Sci. U.R.S.S.*, 32, No. 8; 1941). Nitrate deposits were found by the author in the cracks and cavities of rocks in a zone extending between the limit of the permanent snow and approximately 4,000 m. above sea-level. Rock samples were taken under sterile conditions from the ceilings of such rock cavities and seeded upon nutrient media, in the hope of inducing the development of the bacteria if they were present, but with completely negative results. On the other hand, when rock samples were seeded upon a mineral medium of Knop and Geitler, growth of blue-green algæ was invariably obtained, *Gloeocapsa minor* being the species concerned. Tests of the ability of *G. minor* to fix atmospheric nitrogen gave positive results; after two months of cultivation on Bortel's mineral medium deprived of nitrogen, there was a definite increase of nitrogen in the culture. When molybdenum and vanadium in Bortel's medium were replaced by calcined limestone, a considerable formation of nitrates was observed.

Sex-determination in the Wood-louse

H. W. Howard (*J. Genet.*, 44, 143; 1943) reports further experiments on the sex-determination of *Armadillidium vulgare*. It would appear that the female is the heterozygous sex, but some females produce only males or only females, and others both males and females. It is suggested that the segregation of the X- and Y-chromosomes to the egg and polar body is not at random and may be controlled by cytoplasmic factors or by the Y-chromosome. The considerable data on sex-determination and transmission in natural populations are discussed.

Evolutionary Processes in Crepis

E. G. Babcock and his co-workers D. R. Cameron, J. H. Jenkins, G. L. Stebbins and others have discovered highly important facts in the genus Crepis. In a recent paper (E. G. Babcock, G. L. Stebbins and J. H. Jenkins, *Amer. Nat.*, 76, 337; 1942) there is a concise statement of the more important facts relating to species relationships and origin. The genus is of distinct interest to geneticists since structural hybridity, polyploidy and gene and chromosome mutations are commonly found in the species. The authors show that gene mutations play the most important part in speciation, but that chromosome changes also initiate new forms. Secondary processes in the evolution of Crepis species are polyploidy, apomixis, and interspecific hybridization.

Control of the Club-Root Fungus

The use of a 4 per cent calomel dust raked into the soil before sowing seeds of cabbage, radish, swede, turnip and kohl rabi was found by D. E. Green to be the most successful method of controlling club-root disease (*J. Roy. Hort. Soc.*, 68, Pt. 4; April 1943). Lime, mercuric chloride and two proprietary compounds all gave considerable less control than the calomel under the conditions at the Royal Horticultural Society's Wisley garden. This result is somewhat at variance with other trials, where mercuric chloride provided the best control.

Age Determinations of Intrusive Rocks, Ontario

H. C. Horwood and N. B. Keevil have discussed (*J. Geol.*, 17; 1943) the age relationships of a long sequence of intrusive rocks in the Red Lake area of the district of Kenora, North-west Ontario. Field work has shown that there are ten ages of post-Timiskaming igneous activity. These the authors group into three cycles, which they call early pre-Algoman, late pre-Algoman and Algoman, respectively. Helium age-determinations have furnished corroborative data, unaltered minerals with close-packed structures and high retentivities, such as magnetite, pyroxene and hornblende, having been separated from the rocks and used as index minerals. After appropriate correction the ages of the cycles are estimated as approximately 1,760, 1,490, and 1,360 million years respectively. It is also shown that the final 'Algoman' granite is followed in turn by basic dykes, ore deposits and later basic dykes, all of which have ages of the same order. The adoption of the term 'Algoman' is unfortunate. It has been generally used in Canada for Pre-Cambrian granites of younger age than the Laurentian granites. Since the age of the latter is well established at about 1,050 million years, while the granites and associated rocks investigated by the authors are about 300 million years *older*, it is obvious that these rocks cannot be Algoman in the accepted sense of the term. Apart from this unnecessary introduction of confusion, the authors have made a most valuable contribution to the Pre-Cambrian geology of Ontario.

A New Synthesis of Pyridine

THE reaction of glutarimide with phosphorus pentachloride was studied by Bernheimer in 1882 and he reported that a crystalline compound was formed, to which he assigned a formula. W. W. Crouch and H. L. Lochte (*J. Amer. Chem. Soc.*, 65, 270; 1943) have now shown that the compound is a trichloropyridine, 2,3,6-trichloropyridine, not previously identified. This was hydrogenated to pyridine. Similar reactions with methyl and dimethyl glutarimides yielded the corresponding pyridine homologues, 2,5,6-trichloro-3-picoline and 2,6-dichloro-3,5-lutidine.

Electrolytic Oxidation of Formaldehyde

THE electrolytic oxidation of formaldehyde in acid, neutral, and alkaline solutions, with a variety of anodes, has been investigated over a wide range of current densities by A. Hickling and F. Rodwell (*J. Chem. Soc.*, 90; 1943). The results show a complex dependence on the experimental conditions, but three main sets of oxidation products were distinguished: (1) formic acid and hydrogen, (2) formic acid and water, and (3) carbon dioxide and water. The results are explained by the assumption that the primary oxidation is due to hydrogen peroxide formed at the anode, nascent oxygen and oxides formed with the electrode materials playing supplementary parts. The hydrogen peroxide may oxidize formaldehyde to $CH_2(OH).O.O.CH_2.OH$, which in alkaline solution decomposes into $2H.CO_2H$ and H_2, and in acid or neutral solution into $H_2O + H.CO_2H + H.COH$. The peroxide may also form water and nascent oxygen (which may be partly evolved as gaseous oxygen. The nascent oxygen may oxidize formaldehyde to formic acid and this to carbon dioxide and water, or it may form with the anode a metallic oxide which in acid or neutral solution has very little action but in alkaline solution may oxidize formaldehyde to formic acid, and/or hydrogen and formic acid.

Specific Heats of Hydrocarbons

THE question of the hindered rotation of molecules such as ethane, $H_3C.CH_3$, in which the two groups joined by a single bond encounter potential barriers as atoms or groups on the rotating parts come near one another, has been studied from the side of the specific heats, from which the existence of a sinusoidal hindering potential has been confirmed. In the case of ethane this is approximately 3,000 gm. cal. The experimental results are not always in good agreement, and B. P. Dailey and W. A. Felsing (*J. Amer. Chem. Soc.*, 65, 42, 44; 1943) have redetermined the values for ethane, propane, *n*-butane and *iso*-butane over the temperature range of about 340–700° K., using an adiabatic flow type calorimeter. The agreement between the experimental and calculated values in the cases of ethane and propane is within the limit of experimental error (1 per cent). The specific heat of *n*-butane was slightly higher than that of *iso*-butane, and the results at lower temperatures were in agreement with theory within the limits of experimental error. At higher temperatures deviations are found. In another paper, J. F. Lemons and W. A. Felsing (*ibid.*, 46) give some determinations of the latent heats of evaporation of *n*-hexane, 2-methyl-pentane and 2,3-dimethyl-butane, and find that the latent heat is smaller the greater the branching of the chain.

Demonstrations of Base Exchange

USE of the ordinary bath sponge as a model for demonstration of ionic exchange phenomena has been described by S. Mattson (*Lantbrukshögskolans Ann.*, 10, 56–73; 1942). Demonstrations of simple exchange (calcium and ammonium) and of the valence effect are thereby made easy. One experiment with sponge, using sodium and alkaline-earth salts in conjunction with methylene blue, also shows the lyotropic effect. Methylene blue is very suitable for demonstrating the laws of ionic exchange, as its activity in combination with the sponge acidoid is great enough to allow a considerable displacement of the common cations. Effects of hydrolysis are readily shown, and by inference the formation of soda when a saline soil is leached: the 'classical' theory relating to this is called "one of the most bungled in soil science". Mattson points out the need for making students familiar with the fundamental relationships of ionic exchange. "There is no such thing as a definite exchange capacity of a soil. The capacity to bind base and exchange metal cations varies greatly with the nature and concentration of the ions in solution". The points made would probably have interest for physical and inorganic chemists, especially since Mattson shows how to demonstrate the ability of a silver chloride precipitate to bind and exchange cations. The exchange capacity of "the simple, 'stoichiometric' compound we think of as AgCl" is as great as that of many a sandy soil.

Obscuration around the North Pole

E. G. MARTIN gave an account of an examination of counts of stars in the Greenwich Astrographic Zone (*Mon. Not. Roy. Astro. Soc.*, 102, 5; 1942), a summary of which appeared in NATURE of January 2, p. 27. As these counts were not compiled for the region within 3° of the north pole of the sky, and as it is now fairly certain that there is obscuration in this area, Martin has examined this region (*Mon. Not. Roy. Astro. Soc.*, 102, 6; 1942). The Greenwich counts show that stars of mag. 8 are not obscured and that absorption at a distance of 200 parsecs is unlikely. Other sources were examined in which colour excesses and spectroscopic distances were used with the object of detecting reddening. Seares has given −0·14 mag. as the mean colour index for unobserved *A*0 stars—a figure which has been used to correct the zero of the Harvard photovisual magnitudes—and Martin has examined the *A*0 stars to see if they confirm this figure. He finds that the mean result is −0·07 mag., and, while admitting from other evidence that this may be slightly small numerically, he considers that −0·14 mag. is numerically too large and that its adoption has exaggerated the reddening near the north pole of the sky. There is therefore little evidence of reddening at 200 parsecs affecting stars of mag. 8, and it is suggested that a more reasonable distance is 500–600 parsecs where *A*-type stars of mag. 9·0 or 10·0 are affected. Further research is advocated, but with a number of modifications and precautions in deriving the colour index of *A*0 stars.

VITAMINS OF THE B-GROUP REQUIRED BY INSECTS

By DR. G. FRAENKEL and M. BLEWETT
Imperial College of Science and Technology, London

SINCE our last communication on this subject[1], we have grown five different insect species, *Tribolium confusum*, *Ptinus tectus*, *Sitodrepa panicea*, *Lasioderma serricorne* and *Silvanus surinamensis*, on an artificial diet, consisting of casein 50, glucose 50, cholesterol 1, insoluble part of yeast 5, McCollum's salt mixture 2, water 15, and wheat germ oil 7 mgm./gm. The following vitamins of the B-group were added in pure substance: B_1, riboflavin, nicotinic acid, B_6, pantothenic acid and *p*-amino-benzoic acid (50 μgm./gm. of the dry diet), choline chloride and *i*-inositol (500 μgm./gm.). In a number of parallel tests the vitamins were left out one at a time. The results obtained with Ptinus and Lasioderma are given in Figs. 1 and 2, and all the results are summarized in the accompanying table.

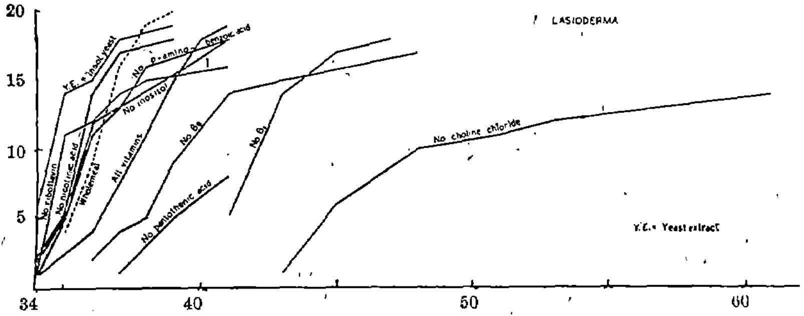

Fig. 2. *Lasioderma serricorne*. EXPLANATION AS FIG. 1.

The same series of tests was also carried out with Tribolium on a diet which contained biotin (appr. 0·1 μgm./gm.) instead of insoluble yeast (Fig. 3).

GROWTH OF FIVE SPECIES OF INSECTS ON DIETS CONTAINING ALL THE CHEMICALLY KNOWN FACTORS OF THE VITAMIN B COMPLEX IN PURE SUBSTANCE (WHOLE DIET) AND ON DIETS WHICH WERE LACKING IN ONE SINGLE B-FACTOR.

	Tribolium	Ptinus	Silvanus	Lasioderma	Sitodrepa
Control: containing yeast extract	++++	+++(+)	++++	++++	++++
Whole diet	++++	++++	++++	++++	++
No B_1	+	±	++++	+++	—
No riboflavin	±	—	++	++++	+(+)
No nicotinic acid	—	—	±	++++	++
No B_6	++	+	+++(+)	+++	+(+)
No pantothenic acid	+	±	±	++	+
No choline chloride	+++	++	+++(+)	+(+)	++
No *i*-inositol	+++	+++	+++(+)	++++	++
No *p*-amino-benzoic acid	+++(+)	+++	+++(+)	++++	++

From these tests, and others, the following conclusions can be drawn concerning the vitamin requirements of insects:

(1) Ptinus and Tribolium require the five major components of the B-complex, B_1, riboflavin, nicotinic acid, B_6 and pantothenic acid as essential growth factors. Silvanus requires only riboflavin, nicotinic acid and pantothenic acid; Sitodrepa, B_1 and pantothenic acid, and Lasioderma apparently none of them. The difference of vitamin requirements of these five insects is, possibly, due to the presence in Sitodrepa, Lasioderma and Silvanus, but not in Tribolium and Ptinus, of intracellular symbiotic micro-organisms, which may supply vitamins.

(2) Choline chloride is an essential food factor for at least two of the insects, Ptinus and Lasioderma, and probably of some importance for Tribolium too.

(3) Inositol and *p*-amino benzoic acid may be of some slight value for Tribolium and Ptinus.

(4) A diet which contains the eight pure factors of the vitamin B-complex, and no source of undetermined water-soluble B-vitamins, is in every respect as good as the control diet, which contains yeast extract, or as wholemeal flour (only exception Sitodrepa). Insects therefore do not seem to require any unidentified vitamins of the B-group.

(5) The only substance which Tribolium requires from insoluble yeast is biotin, provided the diet contains a sterol. With the eight soluble B-factors and biotin supplied in pure substance no further addition of known or unknown vitamins is necessary.

(6) The optimal requirements of biotin for Tribolium are 0·1 μgm./gm. of the dry diet and the threshold of action is between 0·006 and 0·003 μgm./gm.

(7) There are very striking analogies in the requirements of vertebrates and insects of the nine chemically known factors of the vitamin B complex. For both groups, B_1, riboflavin, nicotinic acid, B_6 and pantothenic acid are indispensable, choline and biotin are of some-

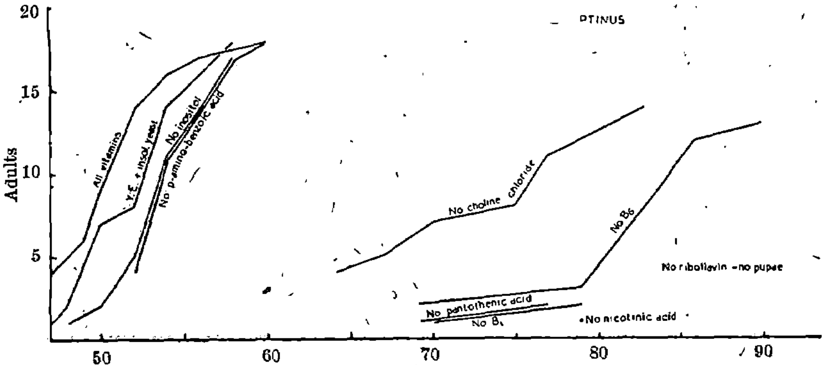

Fig. 1. GROWTH OF *Ptinus tectus* ON DIETS CONSISTING OF CASEIN, GLUCOSE, INSOLUBLE YEAST, CHOLESTEROL, SALTS, WATER AND 8 MEMBERS OF THE VITAMIN B-COMPLEX, COMPARED WITH SIMILAR DIETS FROM WHICH SINGLE VITAMINS HAVE BEEN LEFT OUT ONE AT A TIME.

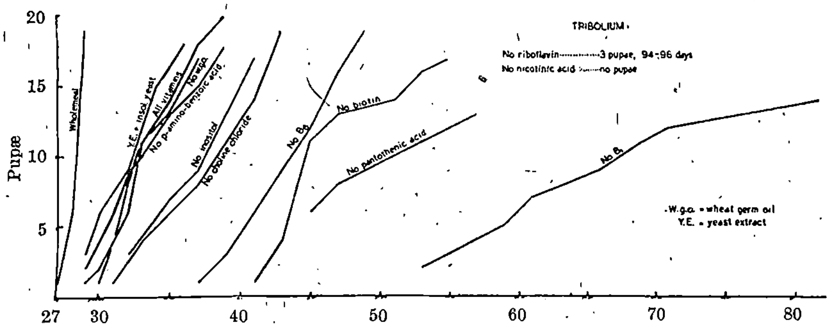

Fig. 3. *Tribolium confusum.* DIET CONTAINS BIOTIN INSTEAD OF INSOLUBLE YEAST. OTHERWISE EXPLANATION AS FIG. 1.

what lesser but still great importance, inositol and *p*-amino-benzoic acid are of minor or perhaps no importance.

(8) Tribolium certainly requires no fat-soluble substance apart from a sterol (cholesterol, ergosterol, sitosterol, or 7-dehydrocholesterol, but not vitamin D) (Fig. 3). There is no evidence so far that fat, or any fat-soluble substance, apart from a sterol, is required in the diet of any insects.

These results essentially agree with and extend recent findings of other authors concerning vitamin requirements of insects. Subbarow and Trager[2] demonstrated the need of the mosquito larva for B_1, riboflavin, B_6 and pantothenic acid, and Tatum[3] demonstrated that the Drosophila larva, in addition to B_1 and riboflavin, also required B_6, nicotinic acid and pantothenic acid. Galleria requires nicotinic acid[4]. In none of these cases did the insects grow satisfactorily without the further addition of yeast or yeast fractions. Barton-Wright's[5] failure to grow Tribolium satisfactorily on artificial diets must have been due to absence of pantothenic acid, choline and perhaps other minor factors from his diet, which may also have been very low in biotin. In sharp contrast to our findings, and those of others, are the recent claims of Rosenthal and Reichstein[6], according to which B_1, nicotinic acid and biotin are the only B-factors required by Tribolium. These differences of results are, in our view, due rather to the use of insufficiently purified ingredients in the diet of these authors than to differences in the insect stocks or to contamination of diets by microorganisms.

We gratefully acknowledge a Government grant, made by the Royal Society, which, partly, made this investigation possible.

[1] Fraenkel, G., and Blewett, M., NATURE, **150**, 177 (1942).
[2] Subbarow, Y., and Trager, W., *J. Gen. Physiol.*, **23**, 561 (1940).
[3] Tatum, E. L., *Proc. U.S. Nat. Acad. Sci.*, **27**, 193 (1941).
[4] Rubinshtein, D. L., and Shekun, L. A., *Bull. Biol. Med. Exper.* (1941).
[5] Barton-Wright, E., NATURE, **148**, 565 (1941).
[6] Rosenthal, H., and Reichstein, T., NATURE, **150**, 546 (1942).

PHYSICAL FITNESS OF SCHOOL CHILDREN IN SOUTH AFRICA

THE population of the Union of South Africa is slightly more than ten millions, of which about one fifth are of European stock. The others, comprising seven million aboriginal Bantus, a quarter of a million Asiatics (Indians and Chinese) and about a million 'coloureds' (that is, Eurafricans and Eurasians) on the whole exist at a lower socio-economic level than the bulk of the white population. Nearly a fifth of the Europeans fall into the category of 'poor whites'—people who, from one cause or another, have lost their sense of responsibility. In fact, they are below the aboriginal race in physique and in general nutritional level. The 'poor white' problem in the Union was investigated in 1929, by Murray, for the Carnegie Commission, and his report, published in 1932, so shocked the *amour propre* of the Government of the Union that, in 1937, it instituted a survey of the state of nutrition of the school children throughout the Union. The results of this survey so far published are scattered through various journals or appear in special reports. In order to make the methods and results of the survey more available, further studies are to be published biannually in a new journal called *Manpower*, the first number of which has recently reached Great Britain*. It contains, besides a very thoughtful and thought-provoking editorial, two original papers by E. H Cluver, E. Jokl and T. W. de Jongh—authors already well known for their researches on nutrition in the Union and for a monumental work on the results of a rehabilitation service for young men.

The first of these articles, on "A National Manpower Survey of South Africa", deals with "The Principle of Physical Performance Grids" while, in the second article, a comparison is made between the physical efficiency standards of Bantu, Chinese 'Coloured', European and Indian children by the use of these 'grids'. In order to "arrive at a basic system of co-ordinates which can serve as an objective interpreter of any subsequent results of individual or group tests which may be conducted with samples of school children of all ages between 6 and 18 years tests had to be selected which were purely objective which could be applied simply and universally and which would give information of distinct physiological significance". The three performance components, skill, endurance and strength, were estimated by the time taken to run 100 yards and 600 yards, and the distance over which a 12 lb. sho could be thrown respectively.

Fault could be found with this choice in that the tests do not solely measure the performance components specified. Other factors intervene. Further anyone who has had experience in assessing the physical fitness of children will realize how difficul it is to get wholehearted co-operation from all subjects, especially from those at the two extremes o the social and intelligence scales. The sophisticated are bored and are apt to treat the tests as a joke while the less intelligent do not try their best. The lower socio-economic classes are generally suspiciou of any test. The authors, however, as their table and graphs show, have succeeded in gaining the co-operation of the majority of their subjects. Thei results are statistically valid except perhaps for the Chinese children, but one hesitates at this stage to accept all the conclusions drawn from the results

* *Manpower* (*Volkskragte*): a Biannual Scientific Journal, Vol. 1 No. 1. Issued by the National Advisory Council for Physical Education, Pretoria. 7*s*.

The authors themselves feel this and state, "We are clearly aware of the elementary nature of our experimental material. The present evidence will have to be extensively supplemented before it can be expected to act as a scientific guide to the physical education profession".

The attempt to carry out large-scale tests of skill, endurance and strength is courageous, and further papers are promised from this source in which these tests will be correlated with somatometric and other measurements. The difficulties of any wholesale methods are appreciated, but the problem facing the health services in South Africa is urgent. The same problem with the same urgency faces us in Great Britain. We have our 'poor whites' and they, like those of the Union, have a high birth-rate and a high infant death-rate, but because they are not compared with a black indigenous race, it is difficult to make the ordinary citizen aware of the difficulties and dangers to the nation of this submerged tenth which, if it maintains its present fertility, will be about a third of the next generation.

The second paper applies the 'grids' worked out in the first paper to the various races found in the Union. The authors do not say how many of the Europeans tested fell into the 'poor white' category, but they certainly weight the result. "In spite of the generally known deficiencies in their environment, in spite of their poor housing conditions, in spite of their bad food, in spite of the manifest insufficiencies of their health services and their education, the Bantu's physical abilities are superior to those of the European's". This superiority is consistent in the girls but variable in the boys. From 12·5 years to 18 the European boy is the equal and generally the superior of the Bantu in the 100 yards and 600 yards race, while at all ages he shows greater strength (putting 12 lb. shot).

From a third article, by P. J. Kloppers, entitled "Personality, Disease and the Social System", we cull the following significant sentence. "It may in truth be said that it is more important to know what kind of a man has a disease than what kind of a disease a man has".

The remaining sixteen pages are devoted to an illustrated review of the literature of man-power studies, both current and classical, ranging from "Animated Statistics", taken from Neurath's "Modern Man in the Making", to reproductions of postage stamps which picture various sports.

D. BURNS.

WALNUT TREES

By ALEXANDER L. HOWARD

CORRESPONDENCE appeared in *The Times* on the subject of walnut trees some years ago, and has now been revived by an article by Sir Stephen Tallents, published in the *Spectator* on January 22.

As some of the correspondents in *The Times* expressed the mistaken opinion that walnuts could not be grown advantageously in England, and also as the majority of trees of any size or quality have been felled in the course of the last twenty years for commercial use of the wood, it would seem desirable to direct attention to the importance of re-planting.

This should be carried out in the interests both of the fruit and the timber. Through ignorance and want of care, perhaps the largest number of those who possess trees have failed to reap a harvest of good walnuts during the last fifty years, but that it is possible to produce equally good quality throughout England and Wales with that provided in Europe is without doubt. To secure a crop of nuts the same attention should be paid to the trees as the owner would pursue in the annual production of other fruits or flowers. The walnut tree needs to be protected from those insects which attack it, and the animals which eat the fruit on the trees, namely, tree rats, squirrels, and birds.

From the time of John Evelyn until a little more than a hundred years ago the planting of walnuts was pursued with vigour throughout England, but by degrees both practice and interest in the subject have insensibly faded away, and in only a few cases has any planting been carried out.

It is evident from very superficial observation that the planting of walnuts in Evelyn's time was general with all classes, poorer or richer. The traveller throughout Kent, by way of Sussex, through Hampshire, Dorset, and down to Somerset and Devonshire, will continue to find walnut trees adorning not only the greater or manor houses, but also villages and the gardens of country cottages.

Unfortunately, during the last fifty years all the larger trees have been eagerly sought for, and however reluctantly, eventually sold to the dealer, who has discovered the great value which the wood possesses. No other timber tree has been in such regular demand, or consistently brought the owners such a high reward during the last century.

John Evelyn's praise of the Virginian black walnut (*Juglans nigra*) has often been quoted. This tree is perhaps in its maturity more attractive than the European (*Juglans regia*), and therefore found favour with Evelyn, who probably did not live long enough to find the disadvantages of attempting to establish it in England, where it is difficult to rear in large numbers. Individual splendid specimens could be found, many of which are noted in Elwes and Henry's "Trees of Great Britain and Ireland"; but inquiry will reveal that they are isolated specimens which, on account of their protected positions, have prospered. The tree grows rapidly in its early life, but does not thrive in the cold damp climate of Great Britain, often failing to harden off its autumn growth in the winter unless in a protected position. These disadvantages do not apply to the European variety, which when grown in England and cared for will compete favourably, both in regard to the timber and the nuts, with the American variety.

It has been found possible to rear trees which had grown to a height of 5–8 ft., and occasionally more, with a girth of 4½–5 in. at two feet from the ground, in four years.

The increased knowledge which has resulted from experimental research work carried out at East Malling has shown that a crop can be expected within a less period of time than was formerly thought possible.

In her generosity Nature has provided us in England with opportunities for the provision of useful fruit and valuable timber: it should be our pleasure and indeed duty to take the fullest possible advantage of these opportunities which she offers.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Saturday, June 19

Institute of Physics (Joint Meeting of the Electronics Group and the Manchester and District Branch) (in the Physics Department, The University, Oxford Road, Manchester), at 2.30 p.m.—"The Electrical Discharge in Gases" (Dr. T. E. Allibone will speak on "Discharge Phenomena" and Dr. J. M. Meek on "Modern Theories of the Discharge").

Monday, June 21

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

Wednesday, June 23

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.30 p.m.—Discussion on "The Applications of Meteorology to Industry" (to be opened by Mr. J. F. Shipley).

Thursday, June 24

Town and Country Planning Association (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Prof. Ernest Barker: "Social Background of Town Planning".

Thursday, June 24—Friday, June 25

British Coal Utilization Research Association (at the Royal Institution, 21 Albemarle Street, London, W.1)—Conference on "The Ultra-fine Structure of Coals and Cokes, with special reference to the Application of Modern Physical Methods".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Milk Advisory Officer (female) to the Holland War Agricultural Executive Committee—The Principal and Executive Officer, Agricultural Institute, Kirton, Boston, Lincs. (June 23).

Second Speech Therapist at the Child Guidance Clinic—The Education Officer, The Guildhall, Cambridge (June 25).

Head of the Engineering Department in the South-East Essex Technical College and School of Art, Dagenham—The Chief Education Officer, *County Offices, Chelmsford (June 25)*.

Psychiatric Social Worker (temporary) to work with the Psychiatrist and Psychologist in the Child Guidance Clinic—The Town Clerk, Town Clerk's Office, Town Hall, Reigate (endorsed 'Psychiatric Social Worker') (June 25).

Assistant Master (temporary) mainly to teach Physics in the Handsworth Junior Technical School—The Chief Education Officer, Higher Education Department, Education Office, Council House, Margaret Street, *Birmingham 3* (June 25).

Assistant (man) in Junior Technical School and part-time Day Classes of Redditch Technical School for Mathematics, Mechanics, Engineering Drawing, Workshop Technology and Elementary General Science—The Director of Education, County Education Offices, County Buildings, Worcester (June 26).

Director of the Transvaal Museum, Pretoria—The Secretary, Office of the High Commissioner for the Union of South Africa, South *Africa House, Trafalgar Square, London*, W.C.2 (June 26).

Lecturers (two) in Building Subjects in the Hull Technical College—The Director of Education, Guildhall, Hull (June 26).

Lecturer in Biology and Hygiene, with General Science—The Principal, Kenton Lodge Training College, Newcastle-upon-Tyne (June 26).

Mistress to teach Geography and Botany in the Nottinghamshire Rural Pupil-Teacher Centres—The Director of Education, Shire Hall, Nottingham (June 26).

Teacher (man) of Mathematics and English in the new Building Trades Junior Technical School at the Hull Technical College—The Director of Education, Guildhall, Hull (June 26).

Head of the Science Department, and a Teacher of General Science Subjects, in Acton Technical College—The Secretary (T), Middlesex Education Committee, 10 Great George Street, Westminster, London, S.W.1 (June 26).

Teacher of Building Subjects in the Junior Technical School and the Technical College, and a Teacher of Mining Subjects (applicants should have industrial and teaching experience and be prepared to teach Mine Surveying), in the Whitwood Mining and Technical College—The Director, Education Offices, Castleford, Yorks (June 26).

Speech Therapist—The Education Officer, Education Offices, Northern Secondary School, Mayfield Road, Portsmouth (June 28).

Psychiatric Worker (temporary)—*The Chief Education Officer*, County Hall, Taunton (June 30).

Lecturer in Animal Husbandry at the Imperial College of Tropical Agriculture in Trinidad—The Acting Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

Teacher of Production Engineering—The Principal, Dolcoath Technical School, Camborne, Cornwall (July 1).

Assistant Engineers (4) in the Department of Posts and Telegraphs—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (July 2).

Woman Psychiatric Social Worker—The Director, School Clinic, 7 Leopold Street, Sheffield (July 3).

Assistant Engineer for the Government of Dominica (should be qualified civil engineer with extensive experience of road construction)—The Secretary, Overseas Manpower Committee (Ref. 904), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

Lecturer in Geography—The Secretary, Homerton College, Cambridge.

Master for Chemistry, and a Master for Building Subjects—The Principal, County Secondary School and Cumberland Technical College, Workington.

Domestic Science Assistant preferably with Degree in Social Science, in the Day Technical School for Girls, and an Assistant for Mathematics, Engineering Science, Machine Drawing, in the Day Technical School for Boys—The Principal, Technical Institute, *Longport Street, Canterbury.*

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 9: *Salmon and Sea Trout of the Waterville (Currane) River*. By Arthur E. J. Went and T. Sankey Barker. Pp. 83–102. 2*s*. 6*d*. Vol. 23 (N.S.), No. 10: Ascorbic Acid, Part 1: Detection and Estimation. By W. R. Fearon and Einhart Kawerau. Pp. 103–110. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [115

Ollsgoil na h-Éireann: The National University of Ireland. Calendar for the Year 1942. Pp. x+614. (Dublin: National University *of Ireland*.) [115

Metallurgical Abstracts (General and Non-Ferrous). Vol. 9, 1942 (New Series). Edited by N. B. Vaughan. Pp. viii+440. (London: Institute of Metals.) [115

The Journal of the Institute of Metals. Vol. 68, 1942. Edited by N. B. Vaughan. Pp. xxxii+430+37 plates. (London: Institute of Metals.) [115

Public Museums, Gloucester. Occasional Papers, No. 5: *Glevum and the Second Legion. By Charles Green. Part 1. Pp. 14. (Gloucester*: Public Museums.) 6*d*. [125

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Planning of Science. Report of Proceedings of the Open Conference held at Caxton Hall, January 30th–31st, 1943. Pp. 127+8 plates. (London: *Association of Scientific Workers*.) [145

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NATURE RESERVES

If one may judge from impressions of casual talk, there is a good deal of confusion in the public mind on the subjects usually grouped under such terms as 'nature conservation' and the like. Many people who have not given much thought to the subject seem to have little more than a vague desire that as much as possible of England's green and pleasant land should be saved from the uglier features of industrial development. There are also many to whom the words 'national parks' suggest only memories of Hampstead Heath on a Bank Holiday, and 'nature reserves' mean only barbed wire and notices threatening the prosecution of trespassers. It may be worth while, therefore, to recapitulate some elementary considerations which, although they have long been familiar to scientific men interested in such matters, are not yet generally appreciated. For this purpose a convenient starting point is given by the recently published report of the Nature Reserves Investigation Committee* which presents, within the compass of a pamphlet of 25 pages, an admirably balanced statement of the purposes of nature conservation and of the methods by which these purposes may be attained.

The objects to be aimed at may be classified under three main headings : amenity, education and scientific study. The report makes a point that is often overlooked when it says that "the beauty and interest of landscape does not depend solely, or even mainly, upon the sculpturing of the earth's surface, but upon the nature of the living carpet which covers and surrounds these physical features". This has only to be stated to appear self-evident. Imagine, say, the Lake District stripped of this carpet, and who would care to visit it for pleasure ? Even the provision of 'national playgrounds', then, involves problems of applied biology.

In speaking of the educational aspect of nature conservation, the authors of the report have in mind chiefly the school teaching of nature study in Great Britain. This subject is now included in the curriculum even of urban schools, and there is already a demand, which is likely to increase, for the preservation of such scraps of wild life as may persist within areas accessible to the pupils. It is suggested that, just as individual schools have their own playing fields, they might also have their own small-scale nature reserves, for the establishment and care of which they would be responsible.

The value of nature reserves for purposes of scientific study scarcely needs to be pointed out, but the report rightly emphasizes the fact that this value is not only academic but also has a very important economic aspect. It requires no great effort of imagination to realize that, as the agriculturist studies in ever closer detail the influence of local differences of climate and soil, valuable indications may be got from the natural or spontaneous fauna and flora of different districts, and "it is also a reasonable assumption that there are still in nature plants or animals of potential, but as yet unknown, value to mankind".

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* Nature Conservation in Britain. Memorandum No. 3 of the Conference on Nature Preservation in Post-War Reconstruction. Issued by the Society for the Promotion of Nature Reserves. (London : British Museum (Natural History), 1943.) 6*d*.

What, then, is this 'Nature' which for these and other reasons we desire to conserve? There is a very widespread impression that on the cessation of human interference, the animal and plant life of any area will speedily revert to a 'state of Nature', a permanent and unchanging condition undisturbed save by the endlessly repeated cycle of the seasons. Nothing could be further from the truth. The 'balance of Nature' is a phrase that comes so readily to mind that we are very apt to forget that it describes not a static and enduring condition but a swaying and uncertain struggle of opposing forces, in which now one and now another obtains a temporary mastery. Botanists have made us familiar with the idea of a natural succession of plant associations, and, apart from the profound reactions of this succession on the fauna, there is increasing evidence that all animal populations are constantly waxing and waning, sometimes in regular cycles, often with seeming irregularity, under the influence of factors that can only be guessed at. In most instances nature conservation aims at the perpetuation of existing conditions, and it should be realized that this can only be achieved by unceasing and scientifically directed measures of control. To take a single example, Wicken Fen, one of the best-known and certainly the most thoroughly studied of the nature reserves now existing in Great Britain, owes its approximate stability to unremitting management, the regulation of drainage, the cutting of reeds, the eradication of brushwood and so forth, far more than to the mere exclusion of collectors.

Apart, however, from this natural instability of the fauna and flora, it has to be borne in mind that there is scarcely a square mile of Great Britain, except on the tops of the highest mountains and the wilder parts of the sea-coast, that does not owe its present aspect in some measure to the activities of man. It is easy to realize this in most scenes of the English countryside, but when standing on a Scottish moor looking over unending miles ablaze with the purple glory of heather, it is harder to remember that the landscape is as much a product of human cultivation as a cornfield or a cherry orchard. Yet nothing is more certain than that the stopping of heather burning for a few years would cover most of these miles with brushwood and incipient forests. It is above all necessary, therefore, that schemes of nature conservation should start with a clear idea of what it is desired to conserve, and that adequate provision should be made for continuous scientific supervision and management. Without this control there is evidence that unexpected and undesirable results may follow. It has been found, for example, that when a patch of woodland in the midst of an agricultural area was isolated and all shooting within its limits prohibited, the woodland was colonized by predatory birds and mammals, which not only exterminated most of its other inhabitants but also used it as a base of operations for raids on the surrounding countryside.

It is to be hoped that the authorities responsible for nature reserves will discourage any attempts at introduction or re-introduction of animals or plants into areas which they do not now inhabit. It is scarcely necessary to point out the futility of suggestions such as that made some years ago for the sowing on Welsh mountains of the seeds of alpine plants from Switzerland, or the attempt, which is believed to have been partially successful, to add the edible dormouse to the list of British mammals. There is, however, a superficial plausibility in the arguments for the re-introduction of animals once native but now extinct in Great Britain. This has been done successfully, for example, with the capercaillie and less successfully, it is understood, with the Large Copper butterfly. Apart from the unpredictable results from any such interferences with the existing fauna and flora, these experiments amount to a wanton falsification of the records of geographical distribution. Modern taxonomy is working towards an ever finer discrimination of sub-species and local races of animals and plants, and, whatever may have been the case with the capercaillie, we are assured that the continental race of the Large Copper, now breeding at Woodwalton Fen and elsewhere, is quite distinguishable from the extinct British race of the species. It is to be deplored that a recent writer has seen fit to suggest, apparently in all seriousness, that the European beaver, the wild boar and the reindeer might be re-established in the Scottish Highlands.

The report makes the valuable suggestion that geological, no less than biological, features of Great Britain may require protection as nature reserves. This is a matter to which little if any attention has hitherto been given in Great Britain. Almost the only example of a protected geological feature that comes to mind is the "Fossil Grove" in Whiteinch Park, Glasgow, where a striking group of carboniferous tree-stumps has been preserved in a building erected over it by the Corporation of Glasgow. There must be many geological exposures all over the country that deserve protection against destructive quarrying.

One of the few aspects of the subject not touched upon in the report is that of river pollution, which, with the proposed redistribution of industry, must threaten many areas hitherto exempt. On one hand, the aquatic fauna and flora are as much deserving of preservation as those of the land and, on the other, a pure water supply is no less needful for any community of animals and plants than it is for any human settlement. There is no point in trying to set up a nature reserve on the banks of an open sewer.

The acquisition, protection and management of nature reserves involve a complex of problems, economic, legal and administrative, on all of which the report makes constructive suggestions. Starting from the admirable (if somewhat nebulous) principle that "the Government should take formal responsibility for the conservation of native wild life", it is recommended that a single central body should be set up to acquire and manage reserves that are of national importance, and to exercise supervisory and consultative functions in respect of reserves held or administered by local authorities. The central body "should be distinct from, and have equal and parallel status with, the National Parks authority", the establishment of which has been recommended by successive Government committees. Whatever the administrative machinery, however, the paramount need for continuous scientific supervision cannot be too strongly emphasized.

COAL UTILIZATION RESEARCH AND THE NATIONAL ECONOMY

THE emergence of coal as a factor of major importance in the war effort of the United Nations is one of the outstanding features of the times. Its importance in Great Britain alone can be measured by the establishment of a Ministry of Fuel and Power, concerned not merely with production but also with utilization of fuel. The Parliamentary and Scientific Committee—a non-party and unofficial body formed to link scientific workers with members of Parliament—has attempted to bring matters to a focus at a meeting on May 4 in the House of Commons, when a report on "Coal Utilisation Research and the National Economy" was adopted. Members of both Houses and others concerned with technical and scientific bodies have joined in its preparation. Statements had been received from experts and also from Major Lloyd George, Minister of Fuel and Power. Copies of the report have been sent to the Lord President of the Council and other Ministers in the hope that they might agree to receive a deputation to discuss the implementation of the proposals.

The report stresses the fact that the life of Great Britain as an industrial nation depends on the supply of energy and raw materials for manufacture. Our climate necessitates the use of large quantities of artificial warmth. The declining productivity of our collieries, it is asserted, must be offset by increased efficiency of utilization. New industries must be created to secure us against unemployment and develop exports. "All these vital objectives demand coal research on a scale never before contemplated in this or any other country. Coal research is an investment which will repay this country handsomely."

The report includes a review of the fuel situation as it may appear after the War, in the light of needs and the present position of fuel technology. In general, the arguments are not new but repeated with greater vigour and urgency than hitherto, and it is instructive to look back and recall how they were received and treated in former times. Royal Commissions in succession have found that the national resources of coal are a wasting and, so far as the choicest and most accessible seams in Great Britain are concerned, a wasted asset. In the early days of this century a gentle effort was made to control the export of coal by means of a small coal tax. This raised economic problems, and in an age when trade had to be kept very free, the tax was short-lived. This indicates an important characteristic of the history of the coal industry. Coal has been regarded by the industry as a commodity to be bought and sold, not as a precious material, capable by means of scientific artistry of being fashioned into an infinity of new forms. The War of 1914–18 found the coal trade, actuated by commercial instincts, sinking costly new pits to achieve expanding exports—which, in the event, have not been realized.

Scientific men even then knew that Great Britain would some day have to cultivate greater thrift in the use of coal, and that this thrift would only be achieved by the application of scientific effort. So far back as 1906, the University of Leeds established a professorship of fuel technology, and in succeeding years the example has been followed to a greater or less extent in other universities. Considering their resources, fuel technicians of the past generation can view with satisfaction the results of their efforts, whether on the chemical or the engineering side, as is shown by figures given in the present report. Fuel problems are world-wide and, broadly speaking, there is no absolute secrecy about them. Ideas or achievements in one country can be adopted all over the world if those concerned choose—which is not always done. For example, enthusiasts for smoke abatement have never ceased to make their advocacy heard and yet, since women received the vote, they have not used their political power to bring forward the smokeless city.

Experience shows that there may be a considerable lag between the gaining of technical knowledge and its applications. In Great Britain, the tradition of individual liberty may even cause a retardation of technical progress. The coal-producing industry—employed and employers—has not helped. Left by the War of 1914–18 saddled with unremunerative collieries, it passed through a period of strife and even passive resistance to fuel efficiency, which led in one mining town to the prohibition of the use of gas-heated wash boilers in favour of coal—the object of efficiency in domestic heating took second place to the maintenance of sales. That this 'raw coal' mind still exists appears from the report itself, which links a plea for the burning of raw coal in domestic fires with far-reaching plans for chemical researches on coal. The chemical values in coal are likely to reside largely if not mainly in the volatile matter, which ought not to be ruthlessly burnt.

At one time, the cost of liquid fuel in Great Britain fell so far that imported mineral oil began to make serious inroads into the normal provinces of coal. In one large city in a mining area with idle pitworkers, a municipal building planned for oil-fired central heating was erected. The gas industry, dealing in a fuel which is above all mobile, has remained organized on almost parochial lines, while the uncontrolled competition between gas and electricity has allowed a waste of capital in the supply services. In addition, the country passed through a period of economic slump, which promoted conservatism, or rather conservation, of old plant and equipment.

The remarks above give just a few examples to show how the application of technical progress may be retarded, especially when the habits and traditions of a nation are involved, as with its methods of heating. It may be a case requiring national action, but State action though powerful is slow. It required the War of 1914–18 to bring about the national Physical and Chemical Survey of Coal Resources of Great Britain. It has required a second World War to evoke a Ministry of Fuel and Power to step in and control or promote efficiency in utilization. This action, which would have seemed revolutionary a few years ago, is a logical consequence of the fuel survey and its revelations of shortages—especially of certain kinds of coal. This fuel economy campaign, launched to secure savings for the war effort, has already had considerable success in stopping the grosser wastes. It provides a survey of utilization conditions in general, and reveals that industry, including the large consumer, if wasteful of fuel, is usually wasteful involuntarily, because it is usually unaware of the inefficiency of its fuel-using installations.

This ignorance of conditions of combustion is unavoidable so long as it is permissible for plant to be installed unprovided with any sort of provision for scientific control. The action of the Ministry's technical staff has aroused increased attention to combustion control, and must, if continued after the War, lead to notable permanent fuel saving. It is an example of beneficent State action which calls merely for the application in industrial practice of existing knowledge, without awaiting the results of long-term research.

This does not preclude the concurrent development of fuel research in Great Britain as widely as is possible or effective. Experiment on a large scale is certain to be slow and may have to await the completion of small-scale preparatory work. The fact that all this takes time is a ground for making an early start. Fuel research is in active progress the whole world over, so that a flood of revolutionary results is not to be expected. Nevertheless, there is always the possibility that men of imagination will make discoveries, but only if they are given the opportunity.

The report makes a survey of the desirable aims for experiment, extending from the cleaning of coal to the preparation of synthetic resins and high-grade aviation spirit—all from coal. The proposals are marked by a prominent interest in the use of raw coal rather out of harmony with the use of coal as a raw material for the manufacture of chemicals. For this latter purpose, it is of course necessary to break up the coal mass into its constituent radicals, which are capable of reassembly to form new and desirable structures. It is very reasonably suggested in the report that an object for a national research policy would be the conversion of coal into fluid fuels (free from ash and sulphur) to the greatest possible extent. It is already permissible to envisage this as a possibility, worthy of a great national effort, to which all the other aspects of coal research now in progress in Great Britain would play a subsidiary part.

APOLOGETIC, OLD AND NEW

Princeps Concordiæ

Pico della Mirandola and the Scholastic Tradition. By Avery Dulles. (Harvard Phi Beta Kappa Prize Essay for 1940.) Pp. xiii+182. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 11*s.* 6*d.* net.

Science, Christianity and Truth

By the Rev. Canon A. E. Baker. Pp. 158. (London: Eyre and Spottiswoode, Ltd., 1943.) 6*s.* net.

THERE might not at first sight appear to be very much in common between Mr. Avery Dulles' able and scholarly monograph on the fifteenth century Italian philosopher, Pico della Mirandola (1463–1494), and Canon A. E. Baker's work of modern popular Christian apologetic; yet it is surprising to find how little the development of the natural sciences has affected the fundamental problems of religion and philosophy. This is all the more remarkable because Mr. Dulles, by his careful examination of the writings of Pico, makes it clear that this philosopher of the Renaissance was not, as some students of his work have maintained, a humanist of the modern type, nor yet an idealist of the Neo-Platonic tradition, still less a Hegel born out of due time. Fundamentally, he was a scholastic, belonging to the medieval rather than the modern tradition, the cleavage between these two being less sharp, in point of fact, than has often been supposed. At the Universities of Padua and Paris, but especially at the former, which in the fifteenth century had become the metropolis of scholasticism, Pico came into fruitful contact with the thought of the medieval philosophers. All his thinking is done in terms of scholasticism, which was by no means the barren fig-tree it has been pictured.

Mr. Dulles has two chapters on Pico's ontology, or theory of being: the first on the ontology of contingent beings, and the second on that of the necessary Being and His existence. In the former chapter it is very interesting to compare Pico's theories about matter with those of modern physics so lucidly stated by Canon Baker in his chapter, "The Story of the Universe". Pico, following Aristotle and Aquinas, was firmly opposed to the idea that formless matter could be real. To affirm the non-reality of matter apart from form is not so far removed from the saying of Sir Arthur Eddington, quoted by Canon Baker at the head of his chapter on modern physical theories: "I am convinced that if in physics we pursued to the bitter end our attempts to reach purely objective reality, we should simply undo the work of creation". Matter and form may both be abstractions from a unity which is indivisible, but the scholastics had in their dichotomy of matter and form an instrument of thought which enabled them to interpret being at all its levels. Pico, Mr. Dulles writes, "saw the whole universe as a hierarchy descending from the simplicity and sovereign reality of Pure Act at the summit, to the virtual nothingness of prime matter at the base".

In his remarkable chapter, "Is There a God?", Canon Baker writes:

"If there be no other ground and cause of existence than the irrational, the meaningless, the unconscious, the blind, then there is no reason to believe that our reasoning arrives at truth rather than error. Particles of matter in motion, the discharge of quasi-electric forces along the paths of least resistance in the brain, determine all our thoughts."

Here again we have an idea which the scholastics would have grasped at once, namely, that the existence of God is pre-supposed in all our thinking, whether we realize it or not.

One idea is commonly supposed to have been the discovery of the Renaissance humanists—that of the dignity of man. But medieval writers dwelt repeatedly on the theme of man's greatness in God. The last two words are important. With regard to Pico's own views Mr. Dulles writes:

"A careful analysis of Pico's statements on the subject indicates, in my opinion, that he, like the medieval scholastics, conceived man's grandeur to lie essentially in his resemblance to God and in his capacity to perform the religious task of reuniting himself and the world to the Creator".

Such an idea of human dignity, inherited from their medieval predecessors, may well have characterized the Renaissance philosophers. But men of science to-day, however much they may wish to do so, cannot endorse this idea, unless they take other ground than that of their science. Canon Baker's words are only too true:

"The scientists, because they can say nothing more of man than that he is the product of evolution, here to-day and gone to-morrow, have no reply to the Nazi or Fascist or Communist assumption that liberty is only a fad or a prejudice and the individual is nothing compared with the Race or State or Working Class".

At a time when the higher education of our younger generation is predominantly scientific, and 'arts' are temporarily (so we hope) in abeyance, a perusal of both these books under notice would do no harm. The monograph on Pico, it is true, deals with topics unfamiliar in that form to those who know nothing of the history of ideas; but those topics are still relevant to life; as for Canon Baker's book, we can imagine no more profitable reading for any young student of science who is attracted by any form of negative dogmatism; and the short bibliographies at the end of each chapter add to the book's utility.

J. C. HARDWICK.

PSYCHOLOGY OF A PRIMITIVE PEOPLE

Stone Men of Malekula: Vao

By John Layard. Pp. xxiii+816+24 plates. (London: Chatto and Windus, 1942.) 50s. net.

HERE indeed is a book, immense, painstaking and prodigious in sheer material. Although not fully competent to appraise its ethnological content, I feel that certain connexions which such a work evokes in the mind of a psychological reader may perhaps be not without interest. An occasion, for example, comes to my mind when visiting Stonehenge with Jung some years ago. Standing at the centre of the mentally reconstructed temple he asked: "What power had that idea which could raise these mighty stones?" When reading this formidable work a rather similar thought began to take shape in my mind. What power does the primitive still possess that can command such an impressive tribute? Why, in fact, are we so compellingly attracted to the study of the primitive mind? The claims of pure knowledge, answers the anthropologist. Maybe, but the passionate character of anthropological controversy makes one sceptical.

These men of Vao, a small island of the New Hebrides archipelago, are still living in the megalithic mentality. Their whole spiritual world is ritually integrated with dolmens, monoliths and stone circles similar to those of the megalithic period in prehistoric Europe. On the outer side, these megaliths are the visible basis of the Maki rite, which is not only the central pillar of their culture, but also lays down their social hierarchy. On the inner side, the rite is connected with a rebirth mystery in which the reborn individual takes on a new name and becomes one with the ancestral dead. It also appears that the stone monuments are erected for the sake of attracting the ghosts who hover near them. They serve, therefore, as a kind of spirit house or consecrated place which tends to localize the ghosts, thus preventing them from interfering with people and making them sick. The dread of ghosts is, moreover, centralized in a monstrous devouring ghost called *Le-hev-hev*, who waylays the souls of the deceased on their journey to join the ancestral spirits in their fiery after-life in the crater of an active volcano. This guardian ghost has to be placated and bought off by the sacrifice of tusked boars with which the souls of the deceased were mystically identified during life. These highly prized tuskers are, in fact, sacrificial substitutes for human victims for whom *Le-hev-hev* still shows a preference in her avid pursuit of human souls.

The lives of these people, social, economic and spiritual, are so intimately bound up with the central rite, and their concern for their fate in the after-life among the ancestral spirits so rules the whole habit of their life, that one is tempted to look for the key to their psychology in this Maki rite.

First, it can be taken as a general postulate that the primitive mind is only loosely integrated. It is not differentiated in the sense of having an organized personality which can preserve the direction and continuity of conscious life. Moral consciousness, in the form of the scrupulous observance of custom and taboo, is invested rather in the social group than in the individual psyche. It is therefore possible to say that the primitive psyche is externalized and, therefore, becomes visible in the form of concrete symbolism, in contrast to the civilized, which is, to some extent, abstracted from the environment, revealing itself in an inner world of images and values. For us, the integration of consciousness is the primary function of education, and the conserving of psychical continuity with the past has in general been taken over by the unconscious psyche. We can observe this vital function symbolized in dreams by running water, or personified in ancestral figures, or in the ancestral tree or house. But with the primitives, this unconscious activity is projected outside them in identification with concrete symbols and ritual objects. Layard refers to this condition when he says (p. 255), "And sacrifice in these islands implies the identification of the victim, the sacrifice, and the mythical being to whom sacrifice is made". There is also an identification of the megaliths and the great gongs used in the rite with the souls of the ancestors. The gongs have a face and mouth painted on them. It is clear, therefore, that, like the bull-roarers in other rebirth rites these gongs represent the ancestors speaking. The whole world of magic consists, in fact, in a similar identification cf active psychical factors with concrete ritual objects.

The key idea, then, which can guide us intelligibly through the labyrinthine complexity of primitive ritual and kinship (and which may also explain the fact that Layard is now practising psychology) is to be found in the recognition that the primordial structure and activity of the unconscious is externalized and [illegible]cretely manifest in primitive social organization. [illegible]ether we speak of the handing down of tra[illegible] or the continuity of culture, or the immort[illegible] the soul, or of reincarnation, we are reall[illegible]ng the same central fact which these men of [illegible]are expressing in their megalithic identification with the ancestor spirits. All human piety is rooted in this feeling or belief in the continuity of life. The very fact, as Layard points out, that cannibalism has become a vital ethical problem to these people demonstrates how the principle of continuity represents the touchstone of human evolution. For inherent in the ritual cannibal feast is the idea that, by partaking of the body of the slain enemy, one not only participates in the brave qualities of the victim, but one also gives him continuity of life. Through partaking of the Elements in the Communion Christ lives again in us. But if the cannibal feast is eaten for the lust of human flesh without this inherent piety, it is regarded as an ethical relapse. In Egypt the continuity of life was vested in the Pharaohs. Only the king was divine, originating in and returning to the sun, and the paramount importance of this idea was symbolized concretely in the pyramid tombs, labyrinths, mummification and care for the dead. Among the men of Vao it is vested in the megaliths, the tusked boars, the Maki rite of rebirth and the whole complex system concerned in dealing with ghosts.

The powers of light and darkness, or of consciousness and unconsciousness, appear to be personified in *Taghar*, the creative deity, "who is held responsible for the organization of *Pete-hul* into four Quarters" (p. 208) and *Le-hev-hev*, the devourer of souls. We are told that the tusked boar is the animal of *Le-hev-hev* given to man by *Taghar*, both as defence against, and in honour of, *Le-hev-hev*, who seems to represent the primordial inertia of unconsciousness. Because of its relatively low level of integration and differentiation, the primitive mind is constantly threatened by 'loss of soul', in other words, disintegration. *Le-hev-hev* must, therefore, symbolize this ever-present danger; whereas *Taghar*, as the passage above indicates, represents the evolutionary urge towards integration and coherence—in a word, consciousness. Disintegration simply means the severance of continuity, or losing the right path.

But *Le-hev-hev* is also honoured because, through the fear of disintegration, the integrated pattern of life acquires its central value. This is beautifully exemplified by a myth recorded by Deacon (p. 650 ff), as also in the labyrinthine sand-tracings shown in Chapter 25. The patterns are drawn by the finger in sand and they all follow the same fundamental plan. The design consists in tracing round and round and in and out within a framework of straight lines set at right angles, or of small circles set in a regular pattern. In this way a geometrical design is formed of a single continuous line, and the finger must not be withdrawn until the entire figure is completed. Deacon explains the origin of this pastime in a myth. The design is regarded as a kind of maze, and these mazes were connected with a special design called "The Path", the drawing of which was an essential item in the journey followed by the ghost to the land of the dead. According to this belief, "Ghosts of the dead pass along a 'road' to Wies, the land of the dead. At a certain point on their way they come to a rock . . . lying in the sea . . . but formerly it stood upright. . . . Always sitting by the rock is a female ghost *Temes Savsap*, and on the ground in front of her is drawn the completed geometrical figure known as *Nàhal* = 'The Path'. The path which the ghost must travel lies between the two halves of the figure, that is, between the opposites. As each ghost comes along the road the guardian ghost hurriedly rubs out one half of the figure. The ghost now comes up, but loses his track and cannot find it. He wanders about searching for a way to get past the *Temes* of the rock, but in vain. Only a knowledge of the completed geometrical figure can release him from this impasse. If he knows the figure, he at once completes the half which *Temes Savsap* rubbed out; and passes down the track through the middle of the figure. If, however, he does not know the figure, the *Temes*, seeing he will never find the road, eats him, and he never reaches the abode of the dead."

I have cited this myth because, to my mind, it contains the essence of the whole problem of the primitive mind. A ghost is, of course, an idea-complex or affect which invades the mind and, through taking possession, alienates the individual from his original nature. If one can know, and remain faithful to, the original pattern, which is, as it were, written in the heart of each man, one cannot be seduced by any ghost, however powerful. But to become obsessed by an idea or affect always means to become fanatical and one-sided: in other words, half the pattern becomes obliterated, and the way between the opposites is lost. This "Path" is the experimental way which each man has to find, and the sand-maze affirms the psychological truth that it is, in a sense, known to each individual. When he is quiet and 'with himself' he knows it. When he gets excited, or is driven by panic fear, he loses it.

However civilized we may have become in our outward appearances, we are nevertheless still primitive beings below the surface. Because of this fact the danger of uprootedness and disintegration remains also for us the greatest peril. We have lost our fear of mischievous and furious ghosts; but we have not yet learned how to deal with the obsessional fantasies and illusions which are liable to sweep through nations like a rushing mighty wind. Instead we project these unconscious ghosts upon our enemies, which is the very root and origin of war.

One of the most important aspects of Layard's research is concerned with the highly complex system of kinship in these islands. I must, however, leave it to the anthropologists to appraise this part of Layard's work at its true value. But the fact that he himself gives it such a prominent place seems to support my idea that the organization of kinship, by its very nature, represents the motive of structural integration and continuity in its most human aspect. Moreover, the diagrams with which he illustrates the system are eloquent, as he points out, of the same principles of balance and quaternity which govern the process of integration in individual therapy.

These New Hebrideans are, as we might expect, bisexual; but whereas the heterosexual component is taken care of by the elaborate rules of kinship, the homosexual is primarily concerned with creating an emotional solidarity among the men who, it is important to note, are exclusively responsible for the Maki rite. As in ancient Sparta, a boy is given to the man as a lover and to instruct in the whole business of initiation into the man's world. Homosexuality, according to Layard, is intimately bound up with the operation of incision or circumcision, and it seems pretty clear that the importance of homosexuality in patrilinear groups is due to the fact that the inspiration of the ancestral spirits is imparted to the novice through the ritual homosexual act. The operation of incision is an act of sacrifice which invariably precedes the initiation into manhood. Since, therefore, the world of the spirits is, essentially, the spiritual world, we can assume that there are certain phases in the evolution of mankind in which the organization and cultivation of the masculine, spiritual principle needs to predominate over the more material and earthly feminine principle. It was, for example, during the formation and building up of the Greek city-states, when the masculine martial qualities were especially needed, that homosexuality was similarly legalized. In this connexion it is instructive to read that man acquires a soul only through sacrifice. Therefore, women and boys have neither souls nor ghosts. The critical importance given to this idea of sacrifice, first in the operation of incision and, later, in the elaborate cultivation of the tusked boars for sacrifice, seems to point to the conclusion that already the idea of gaining spiritual power through the sacrifice of some part of the animal nature has begun to operate, albeit in the primitive concretistic way.

These stray comments give, I fear, only a very inadequate rendering of the immense labours which the author has put into the work. It is indeed a monument erected by a devoted worker to that vast primordial realm which will ever remain the very groundwork and basis of the human mind.

H. G. BAYNES.

ELECTRICAL TECHNOLOGY

Applied Electricity

By A. W. Hirst. Pp. xi+290. (London and Glasgow: Blackie and Son, Ltd., 1942.) 15s. net.

THE mere change of title from 'electrical technology' to 'applied electricity' for the Part I paper in the examination for the University of London degree in engineering means very little to electrical students, who have to study all their subject whatever it is called. That the same course is to be taken by all other engineering students is another matter, and difficulties must arise when the educationist has to decide what amount of his special subject has to be presented to students who are to become civil or mechanical engineers. For the latter, the more subtle aspects of electrical engineering can well be omitted, with more emphasis on the broader issues of economy, types of electric drive, transmission systems, and even protection. The author has used his experience in this matter to present a text-book which covers both this ground and that for the examinations of the Institution of Electrical Engineers—what may be called the step between the electricity of physics and the specialized technology used by the qualified electrical engineer. The selection of material, the examples, emphasis on practical magnitudes, and diagrams are excellent, but one has qualms about non-electrical students taking this course.

There are a large number of footnotes in this first edition, and one wonders why they could not be incorporated in the text, because they are generally highly relevant and give valuable practical hints. There are two criticisms of the author's material which one can make. The first is that electrical engineers are very keen on the difference between electro-motive force and potential difference, and one cannot subscribe to the idea that the terms "ohmic drop" and "resistance drop" are considered as "counter E.M.F. of resistance" or "resistance E.M.F." (p. 70). A resistance may have an E.M.F. in it, but the telecommunications engineer would say that it has something to do with the thermal agitation of free electrons. As a consequence, the author deduces from Kirchoff's laws that "the algebraic sum of all the E.M.F.'s in any closed circuit is zero", which, to an engineer, would be highly fortuitous. Again, "the algebraic sum of the E.M.F.'s in the connected circuit is equal and opposite to the supply P.D.", which is exactly opposite to what an engineer would say, because he identifies the magnitudes of the E.M.F. maintaining the P.D. of a supply only when either no current is taken or the supply has no source-impedance. The engineer would likewise reverse "the vector sum of all the E.M.F.'s in the connected system is equal and opposite to the supply P.D.".

The second point at issue is the source of the torque which drives the rotor of an electrical machine. The author says (p. 41) "the force on the conductor produces a torque"; again (p. 46), "Torque is proportional to armature current multiplied by flux per pole"; also, (p. 171) Fig. 24, (*a*) and (*b*) clearly show forces only on stator conductors, and the text states "the armature rotates under the forces acting on the armature conductors". Now this is physically not so. There is certainly a flux-density at the location of any current-carrying conductor opposite a pole, but this conductor is magnetically short-circuited by the teeth of the magnetic material nearly surrounding such conductor, and consequently the flux-density at the conductor is very low in comparison with the average flux-density over the arc of the opposing pole face. With current in the conductor, the co-existing flux augments the pole flux in the tooth on one side and diminishes the pole flux on the other. It is due to this asymmetry of flux distribution with respect to each conductor that the teeth exhibit an unbalanced tangential force which is the actual force, when taken for all teeth, making the rotor revolve in a motor, or oppose rotation in a generator. Each conductor is actually cutting a very weak field at a velocity greatly exceeding that of the circumferential speed of the rotor. It is an unjustifiable assump
that the conductors are cutting the averag
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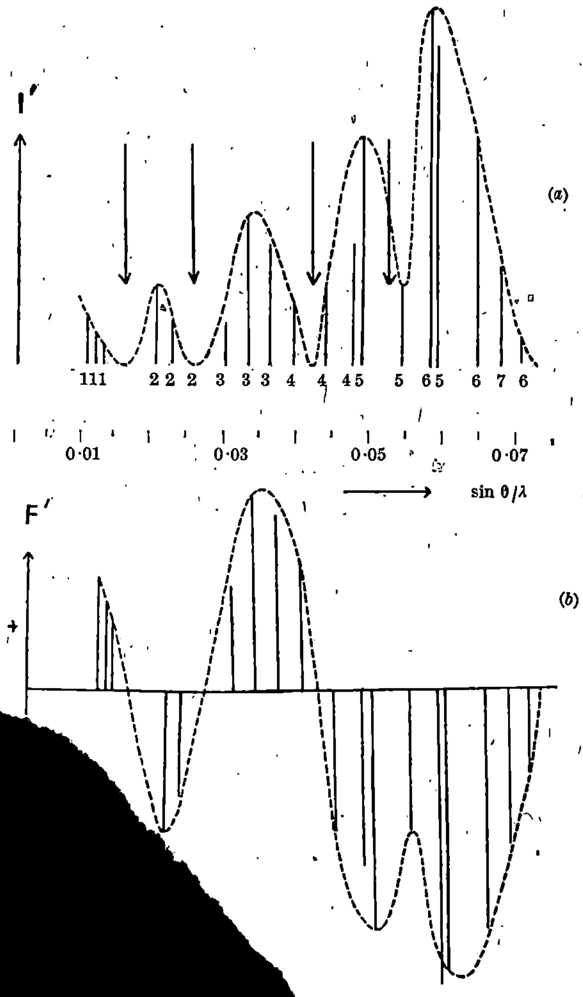
X-RAY ANALYSIS OF HÆMOGLOBIN

By JOY BOYES-WATSON and
M. F. PERUTZ

Cavendish Laboratory and Molteno Institute, Cambridge

IT was shown in a previous article in NATURE[1] that some information regarding the shape and dimensions of the hæmoglobin molecule can be derived from examination of the X-ray pattern of horse methæmoglobin crystals at different shrinkage stages. Further development has now led to the computation of direct Fourier syntheses which show a one-dimensional projection of the distribution of scattering matter in the hæmoglobin molecule.

It had been found that the molecules are platelets about 36 A. thick and 64 A. long. In the crystal, these platelets link up with their neighbours to form coherent layers which remain parallel to the crystallographic c plane at all stages of shrinkage. The liquid of crystallization is distributed in sheets between layers of protein; it was uncertain, however, whether there are one or two layers of liquid per unit cell; in other words, we could not distinguish whether the liquid lies between protein layers one molecule or one half molecule thick.



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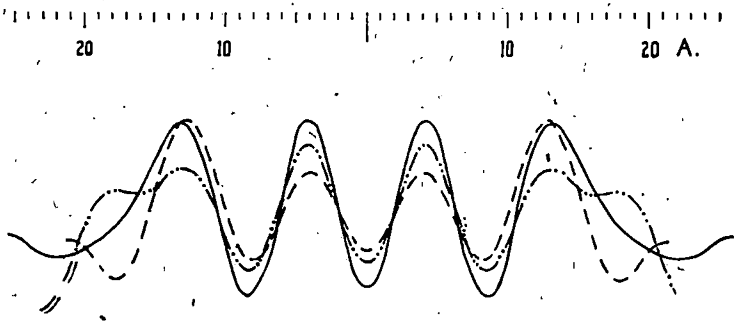

Fig. 2. ONE-DIMENSIONAL FOURIER PROJECTIONS OF HÆMOGLOBIN AT DIFFERENT STAGES OF SHRINKAGE OF THE CRYSTAL.

Each curve represents the electron density distribution in the unit cell projected on to a line which is normal to the c plane. The electron density scale is arbitrary. The plain curve corresponds to the fully wet crystal ($c \sin \beta = 51{\cdot}4$ A.), the dotted one to the first shrinkage stage ($c \sin \beta = 46{\cdot}1$ A.) and the dashed one to the second stage ($c \sin \beta = 42{\cdot}3$ A.).

Since the layers are parallel to the c plane, a one-dimensional Fourier synthesis using the F_{00l}'s as coefficients of the terms gives a picture of the electron density distribution in the unit cell projected on to a line normal to the layer plane. Several such projections calculated for different shrinkage stages should enable us to recognize the hæmoglobin molecule and distinguish it from the liquid of crystallization. In order to calculate the projections, the phases of the F_{00l}'s have to be found. Since the b axis is a diad, the F_{00l}'s are real, and only their signs have to be determined. This was done in two different ways, which both led to the same result.

To understand the first method, we may consider the reciprocal lattice. Since the crystal contracts by the moving together of layers which remain parallel to the c plane, the reciprocal lattice expands by the moving apart of points along equidistant lines which are parallel to the c* direction (Fig. 1 of ref. 1). The 00l points will move along the c* axis away from the origin. Supposing we could record the intensities of the 00l's at a very large number of different shrinkage stages and plot them on a diagram with the intensity as ordinate and c* axis as abscissa, then we should get an 'I curve' from which the molecular scattering F curve can be derived. It has been shown in the former paper that this F curve is constant and independent of the degree of shrinkage of the crystal. Wherever the F curve passes through zero and changes sign the 'I curve' touches the horizontal axis. Once we know the nodal points at which this happens, the sign of any individual F_{00l} relative to the others would follow directly from the position of the corresponding reciprocal point on the c* axis.

In reality we were only able to record four shrinkage stages. The last of these, the air-dried stage, yielded pictures which were too poor for the intensities of the 00l's to be measured. If we plot the intensity of the 00l reflexions at each of the first three stages along the c* axis in the way described above, then we obtain the diagram shown in Fig. 1a. It is seen that the number of points is insufficient to outline the 'I curve' unambiguously. There is one point,

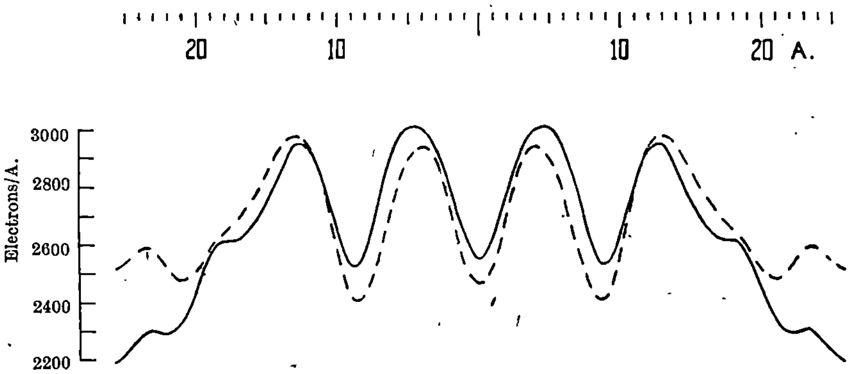

Fig. 3. ONE-DIMENSIONAL FOURIER PROJECTIONS OF HÆMOGLOBIN PLOTTED ON AN ABSOLUTE ELECTRON DENSITY SCALE.

The plain curve corresponds to the salt-free crystal and the dashed curve to the salt-containing one. Both crystals are in the fully expanded state.

however, where we know from the absence of a 002 reflexion that the curve touches the horizontal axis; so this must be a nodal point on the F curve. There are three other points where the 'I curve' might or might not touch the axis. Taking none or any or all of these in turn to be nodal points, eight different F curves can be drawn. These lead to eight different combinations of signs among the F_{00l}'s. Each of these combinations was substituted in turn in three Fourier syntheses corresponding to the first three shrinkage stages.

The first and most striking result was this: whatever combination of signs was used in the syntheses, the solutions were incompatible with more than one layer of liquid per unit cell. Thus the possibility that the hæmoglobin molecule in the wet crystal might consist of two platelets with variable amounts of liquid in between is ruled out; the protein layers in the wet crystal must be one molecule thick and the liquid of crystallization purely intermolecular.

Finally, the correct combination of signs of the F's was found without great difficulty by rejecting all those solutions incompatible with the size and density of the hæmoglobin molecule and its relation to the diad axis. This procedure led to the exclusion of all but one of the sets of curves; this is shown in Fig. 2. The significance of the curves will be discussed below.

Fortunately we were able to derive the signs of the F's more directly by a method which was largely independent of the one described above. Dr. E. F. Hartree supplied us with a new variety of horse methæmoglobin crystals which were prepared by electrodialysis of a highly purified methæmoglobin solution against water, instead of being grown by dialysis against a concentrated solution of ammonium sulphate as before. The new crystals were isomorphous with the usual variety and contained the same volume of liquid, the only difference being that now the liquid was water whereas before it had been ammonium sulphate solution. The X-ray patterns obtained from the two kinds of crystals—salt-containing and salt-free—were practically the same except for striking differences in the intensities of the low $00l$'s. These differences were used to work out the signs of the F's.

The method was similar in principle to that introduced by Cork[2] in determining the signs of the F_{hkl}'s in an isomorphous series of alums containing metal atoms of different weight. Our argument may be outlined as follows. The liquid of crystallization fills the space between the protein layers. Since we know the thickness of the protein layers, both the thickness of the sheets of liquid and their distance apart can be calculated. Hence it is possible to work out which of the F_{00l}'s ought to increase or decrease in value on substituting pure water for ammonium sulphate solution as liquid of crystallization. By comparing the results of these calculations with the observed intensity changes, the signs of some of the F's could be determined. This led to the exclusion of all but two of the possible combinations of signs; one of these was identical with the solution arrived at by the first method, while the other had to be rejected for the reasons mentioned in the last paragraph. In Fig. 3 the electron density curve for the salt-free crystal is compared with the curve for a salt-containing one. Fig. 1 shows the I and F curves which resulted from the determination of the signs of the F's.

In interpreting the curves of Figs. 2 and 3, we take it that the four-peaked structure in the centre corresponds to the protein and the depression at the outside to the liquid of crystallization. In Fig. 2 the width of the depression varies according to the degree of shrinkage of the crystal. In Fig. 3, on the other hand, the depth of the depression differs in the two curves, and is smaller in the case of the salt-containing than in the salt-free one. In the latter case the electron density at the bottom of the depression ought to correspond to that of pure water; this was verified experimentally by measuring the absolute intensity of the 001 reflexion, thus

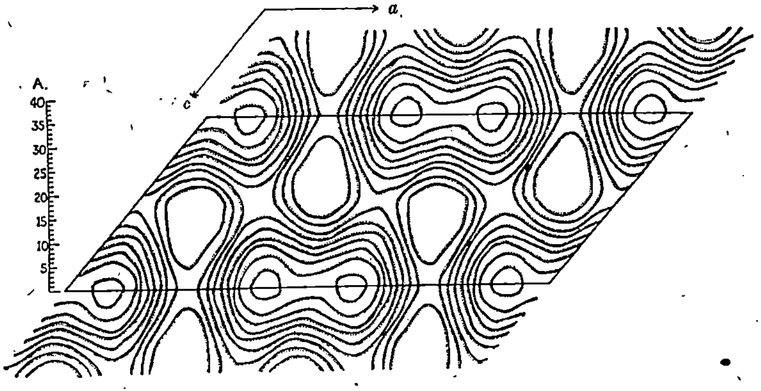

Fig. 4. TWO-DIMENSIONAL FOURIER PROJECTION ON THE b PLANE, SHOWING HÆMOGLOBIN MOLECULES.

The crystal is air-dried. The contours are lines of equal electron density drawn at arbitrary intervals.

putting the electron density curves on an absolute scale.

The protein portion of all the curves shows four roughly equal and equidistant peaks which are a little less than 9 A. apart. This suggests a hæmoglobin molecule consisting of four equal and parallel layers of scattering matter. There might be four layers of polypeptide chains with the main chains folded in the plane of the layers and the side chains protruding at right angles to them. The polar side chains, which make up about one quarter of the total, could occupy the two outside surfaces of the molecule, while the non-polar side chains could be tucked away in the six interior surfaces of the four layers, thus making the molecule impenetrable to water. If the hæmoglobin molecule consists of sixteen separate polypeptide chains, as Chibnall suggests[3], four folded chains extending in the direction of the *b* axis could easily be accommodated in each of the four layers. A molecular model of this type fits in well with all the evidence which has been brought forward up to the present; it is reminiscent of the structure postulated for egg albumen by Astbury some years ago, or of the structure of antibodies suggested by Pauling[4,5]. We should like to emphasize, however, that the model is only one of several possible ones between which there is little to choose as yet, and that it would be premature to draw any final conclusions.

For further progress a two-dimensional projection of the molecule is needed. A first step in this direction has been made by analysing a picture from an air-dried crystal showing four reflections only (001, 200, $\bar{2}01$, $\bar{4}01$). Taking all possible permutations of signs of the corresponding *F*'s, two-dimensional Fourier syntheses were calculated for each of them. We were surprised to find that this led to not more than two different solutions. One of these is highly improbable, because it shows molecules which are much too small and heavy compared with the background. The other solution gives a contour map of dumb-bell shaped molecules (Fig. 4). The resolving power of this method is naturally very poor and is insufficient to show up any detail—indeed, some of the features shown in the picture may be of a spurious nature. Nevertheless, with all its shortcomings, it is the first direct picture of a small protein molecule. The overall dimensions of the molecule on the map agree well with those calculated from other X-ray data; its width along the *a* axis appears to be 48 A.

Summing up, we may say that the hæmoglobin molecule is a platelet having the approximate dimensions 36 A. × 64 A. × 48 A., that it is rigid under the ordinary conditions of swelling and contraction of the crystal, and that it is probably made up of four parallel layers of scattering matter, which are a little less than 9 A. apart.

We wish to thank Sir Lawrence Bragg for his great help and encouragement, and also Dr. D. Crowfoot, Dr. H. Lipson and Dr. A. J. C. Wilson for much stimulating discussion and criticism. Our thanks also go to Prof. D. Keilin and Dr. E. F. Hartree for their continuous supply of crystals. We are indebted to the Rockefeller Foundation for financing this research.

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FIBRINOGEN AND FIBRIN AS MEMBERS OF THE KERATIN-MYOSIN GROUP

By Dr. K. BAILEY, Dr. W. T. ASTBURY, F.R.S., and Dr. K. M. RUDALL

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In the course of preparing an article on muscle proteins[1], it became apparent that the analyses and other properties of fibrinogen are more myosin-like than perhaps had been realized. It was decided to go into the matter further by means of X-rays, with special reference to what happens when fibrinogen is changed to fibrin during the clotting of blood. The problem is of such wide interest that we think it worth while to give a short account of our observations to date, even though confessedly much work remains to be done.

In the first place we have demonstrated that both fibrinogen and fibrin do indeed belong to the keratin-myosin group of fibrous proteins. X-ray and related studies of the keratin-myosin group have frequently been reported on in these columns and elsewhere[2], and we need only recall here that the group has been found to include not only the fibrous proteins of the epidermis of mammals, amphibians and certain fishes[3], and the fibrous structures such as hair, horn, nails, etc., that arise from the mammalian epidermis, but also the principal muscle protein, myosin. All these are endowed with reversible, long-range elasticity, and all give two kinds of X-ray diffraction pattern, so-called α and β, according as they are unstretched or stretched. Fig. 1*a* (cf. Fig. 2*a*) shows an X-ray fibre photograph of oriented fibrinogen, prepared from human plasma by three times precipitation with ammonium sulphate. There is no doubt that this is the familiar α-pattern, though a little obscured by 'extraneous' matter, probably partly lipoid and partly protein unavoidably trapped from other blood constituents. In the ordinary way the fibrinogen photograph—we have examined a variety of preparations—is considerably overlaid with secondary rings and haloes. We are still investigating this point, but we find, for example, that a few minutes treatment of a fibrinogen film with 0·2 per cent caustic soda, followed by washing, both cleans up the photograph and facilitates orientation by stretching and subsequent transformation into the β-form. We prefer, however, to postpone judgment for the time being on such questions as what constitute the 'best' fibrinogen preparations, the 'best' X-ray photographs, etc. Our immediate concern was to demonstrate that fibrinogen is a genuine member of the keratin-myosin group; and in this connexion we have shown over and over again that the fundamental molecular plan of the group (the α-fold) and certain basic elastic properties are conserved over wide variations in chemical constitution[4].

Precipitated fibrinogen, or moist strips of film made by drying a sol on a glass plate, exhibit obvious long-range elastic properties; but the internal cohesion of such specimens is not high, and it is not possible to do more than initiate the α-β intramolecular transformation by direct stretching before rupture occurs. We have overcome this difficulty by falling back on our experience with keratin and myosin, both of which pass readily from the α- to the β-form when elongated by squeezing laterally. With the aid of a device to be described in a later publication, we have succeeded in squeezing fibrinogen into long thin threads that give X-ray photographs of the kind shown in Fig. 1 *b* (cf. Fig. 2 *b*). This is the familiar β-pattern, arising from almost fully extended polypeptide chains.

The other side of this investigation, of course, has to do with the mechanism of the clotting of blood—the change-over from soluble fibrinogen to insoluble fibres of fibrin. We have examined fibrin prepared from human plasma in a number of ways, and our conclusion is that its molecular configuration is essentially the same as that of fibrinogen. Katz and de Rooy[5] reported that fibrin gave the β-keratin pattern, but it seems clear now that they were misled by the results of high extension. We have repeated their procedure as described, but even so we find a weak but unmistakable α-pattern besides the β-pattern. Our observations are as follows: that fibrin stretched just sufficiently to produce orientation is mostly in the α-form with always a certain amount of poorly oriented β-form present; but that the amount of β-form increases rapidly on further stretching, though it is not possible by simple stretching to transform all the α-form before rupture occurs.

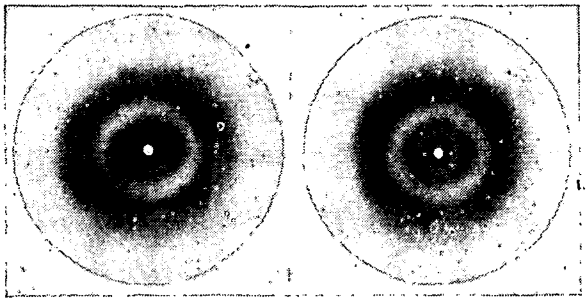
(*a*) α-FORM (*b*) β-FORM

Fig. 1. X-RAY FIBRE PHOTOGRAPHS OF FIBRINOGEN.

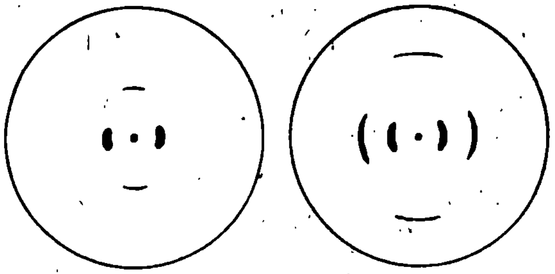
(*a*) α-FORM (*b*) β-FORM

Fig. 2. ILLUSTRATING CHARACTERISTIC FEATURES OF FIG. 1 THAT ARE DIFFICULT TO REPRODUCE WITH THE CLEARNESS OF THE ORIGINAL X-RAY PHOTOGRAPHS.

On the face of it, this could mean that fibrin is intrinsically a mixture of α- and β-forms; but it appears much more likely that primary unstretched fibrin is in the α-form, and that a small amount of β-form is generated inevitably in the rough and tumble of gel formation among the constituents of the plasma, and also in subsequent manipulation for the purpose of obtaining an oriented X-ray photograph. In other words, fibrin is no other than an insoluble modification of fibrinogen without any fundamental change in molecular plan; but also it is in a higher state of aggregation, as is evidenced by its greater internal cohesion and ease of transformation into the β-form by stretching, and by the evolution of visible fibres from the rod-like units that confer on fibrinogen sols their property of flow-birefringence[6]. The appearance of long straight fibres radiating from corpuscles in the blood clot strongly suggests that they are formed primarily by end-to-end accretion of fibrinogen units, but we hope to be able to throw more light on this supposition by examining with the electron microscope the structure of clots that have been freeze-dried before synæresis takes place. Once the primary mechanism of aggregation is established—whether by way of end-groups or by way of side-chains—the way is open to a more detailed chemical study of the phenomenon.

Nature of the Clotting of Blood

A word of warning may not be out of place with regard to other methods of clotting fibrinogen[7], and with regard to conclusions that have been drawn that clotting is only an example of denaturation[8]. Everything depends on what is meant by denaturation. A dried myosin film is denatured in the limited sense that it has become insoluble, but it is *not* configurationally denatured, for it is still in the folded α-form. But when myosin is heat-denatured, for example, it passes into the unfolded β-form, and then it is truly denatured in the configurational sense. When fibrin is produced from fibrinogen by the action of thrombin there is little or no configurational denaturation; for though there is loss of solubility as when myosin is dried, it also remains in the α-form. Some of the kinds of clot other than the physiological may conceivably be, and probably are, aggregates of fibres in the β-form, produced by a different chemical mechanism. At the moment we are studying clots formed *in vitro* from fibrinogen, prothrombin, calcium ions and cephalin[9], and thence we hope to proceed to an examination of non-physiological cases.

It is not necessary, of course, to emphasize the importance of any theoretical or practical contribution to our knowledge of the clotting of blood, but taking the long view, the knowledge that fibrinogen and fibrin are additional members of the keratin-myosin group is of greater significance. The biogenetic implications strike deep. When we consider that the fibrous proteins of the epidermis, the keratinous tissues, the chief muscle protein, myosin, and now the fibrinogen of the blood, all spring from the same peculiar shape of molecule and are therefore probably all adaptations of a single root idea, we seem to glimpse one of the great co-ordinating facts in the lineage of biological molecules.

For part of the work described above, and also for what remains to be done, we are grateful for the collaboration of Dr. W. C. Evans of the Leeds University Medical School, Director of Laboratories, Region No. 2 Blood Transfusion Service, Ministry of Health. The investigation is financed from a grant by the Rockefeller Foundation.

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[8] See, for example, Wöhlisch, E., *Kolloid-Z.*, **85**, 179 (1938).

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PHOTOGRAPHY AS A SCIENTIFIC INSTRUMENT

THE first meeting of the newly founded Association for Scientific Photography was held at the Royal Institution on June 5. Prof. J. Yule Bogue, in his opening address, on applied photography, said that with the rapid growth of science and technology in the last decade, workers, whether they be in the industrial or purely scientific fields, have found it increasingly difficult to keep in touch with the recent advances in fields other than their own. Any particular branch of industry or science is largely dependent for its own advancement upon the progress made in other branches. In order that the maximum benefits may accrue, it is essential that knowledge of these advancements be disseminated as widely as possible. The Association for Scientific Photography has been formed to do this in respect of the development and application of photography as a scientific instrument in industry, technology, medicine and science. The association will assist its members in the solution of problems of development, production and research, by the application of photographic methods. It caters primarily for those who apply or could apply photographic techniques to their work, as opposed to photographers who are interested in the application of their work to scientific problems. It is essential, therefore, that there shall be close co-operation with those concerned with the technical developments of photographic science, so that the results of their work shall be readily available for application by those working in science and industry.

The applications of photography to industrial work, development, and research are enormous. Some indications of this are given in the questionnaire which members are required to fill in, stating whether they are interested in the application of photography to pure research, for example, tracks of atomic particles; or industrial research, for example, the study of vibration in air-screw blades; or production, for example, the radiography of castings; or recording for instructional purposes, for example, documentary kinematography.

He thinks that one important result of the meetings of the Association would be the bringing together, through a common interest, of workers from widely different fields of industry and science. This will be to their mutual advantage, for not only will they discuss their photographic problems, but also their particular lines of investigation.

Prof. Bogue then dealt with some specific applications of photography, confining his choice to a few examples which incorporated several photographic techniques and had more than one specialized application. By the *Schlieren* photographic method, changes in the refractive index of the atmosphere are made visible. The changes may be sudden, such as those produced by the detonation of explosive mixtures, or they may be slow, such as those brought about by changes in temperature. The method has been used successfully in conjunction with the high-speed camera, in studying the properties of aerofoils. The design of radiators, heating elements, and heat-dissipating surfaces, also lends itself to this form of control. With stroboscopic light sources, using gaseous discharge lamps and oscillating circuits, photographs of the distortion of air-screw blades rotating at high speed can be made. The modern gaseous discharge lamp can be made to give an exposure so short as 1 μsec. ($=0 \cdot 000001$ sec.), and can be used with either the still or high-speed camera.

Photo-elastic analysis has obvious uses in the study of components of machines and other structures subjected to stresses. This technique has also proved of value in understanding the stresses set up in the brain as a result of head injuries.

Photo-micrography has a wide range of application, from the control of galvanizing and the study of metal structure, to the study of fibres in the textile industry and histological investigations in medicine. Time lapse kine-photomicrography, for example, has yielded much information on the development of the mammalian ovum, which could not have been obtained by any other means.

Photography has many applications in medicine. Mass radiography, for example, has been assisted by the development of wide-aperture lenses and special emulsions, thus closely linking radiography and photography. Indirect radiography is not confined to diagnostic work; it has also proved invaluable in the study of normal function. The 16 mm. film has become one of the most useful media for teaching and research purposes in biology and medicine. The study of living things in action lends itself particularly to kinematographic analysis.

A colour film of the contraction of the spleen was then shown to demonstrate the value of split-screen work for teaching purposes.

In her paper on "Indirect Radiography as Applied to Medical Work," Miss K. C. Clark dealt with that branch of radiography in which the image on the fluorescent screen is photographed. A still indirect radiograph is obtained when a single exposure is made on a small film, or a kine-radiograph, recording movement, when a kine-camera is employed.

Indirect radiography has enabled the Ministry of Health to launch a scheme which eventually may lead to every member of the community having his or her lungs examined annually by miniature radiography. This examination is for the purpose of discovering symptomless tuberculosis of the lungs, which may only be apparent on X-ray examination and which may not be discernible by routine medical examination. Such an examination of large numbers at sufficient speed, which was impossible by the direct method, has been solved by the application of miniature radiography.

The first practical application of the method was in Brazil in 1934. It has since been employed for the native miners in South Africa, in the Fighting Services, in Australia and America, and in Germany. It has been left to Great Britain, after employing the method to examine men and women in the Services, to introduce a national scheme, which, beginning with the twenty-five special X-ray units, will eventually and by gradual infiltration service the whole country. New units are being delivered each month and personnel trained in their operation. With one of these units, subjects are being examined at a rate of more than 500 a day. The unit can deal with four persons a minute, and the whole process for each person—undressing, taking information for records and identification purposes, and redressing, takes 10–15 minutes. The size of film used for this work is still a matter for discussion; the most widely used in Great Britain is the 35 mm. cine film. The lenses have an aperture ranging from $F/1$ to $F/2$. Miss Clark uses the Taylor, Taylor and Hobson $F/1 \cdot 5$

coated lens. In most units a fluorescent screen is fitted to the wide end of a light-proof tunnel which has an automatic camera at the smaller end. These specially designed cameras are linked with and operated from the X-ray exposure control. Identification is ensured by illuminating the serial number on the subject's card and photographing it on to the base of the film upon which the radiograph is taken. Since the patient hands his card to the operator, there is no possibility of error. The average exposure time is 0·1 sec. or 20 mA.-sec., with a variation of 2 kilovolts for each half inch of chest thickness, with a reduction of time down to 0·05 sec. for smaller thicknesses, and an increase in time to 0·2 sec. for outsize subjects.

Special training is needed in the handling of miniature films, as minute defects show up on projection, especially when the viewer sits within 20 in. of the white matt surface screen. These films are viewed at a rate of 200–450 an hour. A complete radiological interpretation is never given on a miniature film, and a film showing a technical error is never repeated on a miniature. For both reasons, subjects are recalled for full-sized X-ray examination ; about 5 per cent are recalled, but the number found to have tuberculosis does not exceed 1 per cent.

Miss Clark then mentioned points for future discussion, which included various aspects of design of the X-ray equipment, screens, cameras, films and processing. Mention was also made of the 5 in. × 4 in. method used in the United States. This is much slower than the 35 mm. film method, because the individual films have to be handled separately throughout, though there is the advantage of direct viewing without enlargement. The paper concluded with a brief reference to indirect kine-radiography, in which the screen image is photographed by means of a 16 mm. camera fitted with an $F/0{\cdot}85$ lens. At present, this work is chiefly of academic interest and is used for research purposes.

In his paper on "Some Miscellaneous Applications of Industrial Radiography," Dr. L. Mullins described the diverse applications of radiography for inspection and also its use purely as an investigational tool incidental to the main problem. He mentioned that radiography as an inspection technique is playing an ever-increasing part in the national war effort, not only in the well-known application to the examination of castings and welds for porosity, cracks, slag inclusions and other defects, but also in the inspection of such products as electric cables, plastic assemblies, transformer windings on cardboard formers and wireless valves.

The application of radiography to the examination of wireless valves provided Dr. Mullins' first example of the use of X-rays as an investigational tool, since they may be applied in the study of filament distortion while the valve is working. Radiography has also been used in the determination of the rate of increase in the compressive stress in steel due to nitriding. In this work, reported by Betteridge, a flat steel strip, with its underside protected from nitriding by tin plating, was placed in contact with a steel block in the nitriding furnace. Radiographs made through the walls of the furnace prior to and during nitriding revealed the curvature caused in the steel strip and enabled calculation of the stress at the various stages concerned. Additional radiographs made during cooling provided information on the differential expansion of the metal core and the nitride casing.

Further examples of this type concerned the determination of the internal bore of glass tubes, of capillary measurements involving liquids in opaque tubes and of the viscosity of tooth paste, and an investigation of the nature of sodium silicate bonds in corrugated cardboard. This last application provided hitherto unknown information concerning the physical structure of the adhesive joint, the location of the adhesive within, and on, the paper, and the relation of the joint structure to the physical properties of the corrugated board.

As examples of the applications of X-rays in biology, Dr. Mullins cited investigations on the movements of death watch beetle larvæ, and the radiographic method for the vitamin D content of cod liver oil for poultry feeding.

Where rapidly changing phenomena, such as the movement of a piston within an opaque cylinder, have to be examined, kine-radiography has proved of considerable value despite the limitations on its scope, due to the fact that the intensity of the photographic effect on the recording medium is entirely dependent on the output of the X-ray equipment. Two techniques are available : first, the *indirect* method, in which a kine-camera is used to record the fluorescent screen image ; and seondly, the *direct* method in which the X-ray beam, after passing through the specimen, is recorded directly on kine films. In the latter technique greater taking speeds may be achieved by the use of intensifying screens in contact with the film. The direct method was used by Sack in a study of the metal drop formation in electric welding. Previous photographic studies using slow-motion kine techniques had provided incomplete information owing to the presence of hot gases and vapours in the welding zone and the very bright welding arc ; these difficulties had, however, been overcome to some extent by the use of infra-red sensitive materials and suitable filters. X-ray technique not only surmounted these difficulties but also enabled differentiation between the core and coating of coated welding rods. Sack's apparatus was designed to take twenty-five frames every two seconds, and the results obtained provided extensive information on the nature of the drop formation in various circumstances, showing, for example, that, with heavily coated electrodes, the drops form within the coating and fall before their diameter exceeds that of the electrode.

Where the effect being studied takes place in too short a time for kine-radiography to produce useful results, the possibility of high-speed radiography should be considered. Many attempts have been made to produce X-ray tubes capable of generating and withstanding very high instantaneous loads. Steenbeck and also Kingdon and Tanis have described X-ray tubes in which a pool of mercury serves as the target : the disadvantages of this design are that the mercury must be cooled to maintain a low vapour pressure and that the X-ray tube can be used in only one position. Oosterkamp devised an X-ray tube for this purpose in which high instantaneous loads are applied by discharging a condenser across the tube while momentarily increasing the filament current. Recently Slack and Ehrke have described a cold-cathode X-ray tube across which a bank of condensers is discharged by a relay linked with the effect being studied. This tube is capable of providing an electron flow across the tube as great as 2,000 amp. at 100 kV. for a millionth of a second.

With this equipment Slack and Ehrke have already investigated, among other things, the passage of bullets through wood, the movements of the bones in the foot when kicking a ball and the movement of dust in the intake duct of a vacuum cleaner.

In closing, Dr. Mullins said that, as this brief survey would show, the scope of industrial radiography is indeed wide, and he ventured to suggest that, with the active co-operation of radiographers and of the manufacturers of X-ray equipment and X-ray films, even wider applications than are considered feasible at present would become evident.

C. D. Reyersbach's demonstration of "Sub-standard Kine-photo-micrography" was presented by J. Alsop. The purpose of the demonstration was to indicate the application of the kine-camera to photomicrography for determining and recording the movements of small bodies. This was dramatically shown in a colour film of pond life and the growth of crystals. The film was made by the author in collaboration with Alsop, L. Elliott and A. Sabin. The apparatus required is that used for still photomicrography, with the addition of a kine-camera. It is desirable and useful to incorporate an optical arrangement enabling the operator to watch the field of the microscope while the exposures are being made; this was done in the case of the film presented.

The method of dark-ground illumination used was a differential one, the object of this being to increase contrast, while at the same time minimizing glare that is apt to arise with rather transparent objects when ordinary dark-ground illumination is used. This illumination is obtained by mounting behind the condenser of the microscope a central disk of one colour with a disk of another colour around it. The colour of the central disk will then provide the background, while the object will be illuminated by light of the colour of the outer disk. In the case of the shots showing the growth of crystals, a polarizer and analyser were used. The examples shown were all low-power work, but the principles are precisely the same where higher powers are required. The problem of exposure is one which requires careful consideration, and it is found that the exposures required are considerably shorter than anticipated. The exposure of short test strips, together with a complete record for future guidance, is advised.

Mr. H. McGregor Ross, in his paper "The Photography of Photo-elastic Stress Patterns", said that photo-elastic stress analysis offers the engineer a most effective method of solving problems of stress distribution. It is not only frequently simpler and quicker than other methods, but also it may be used to solve problems otherwise insoluble or at least demanding tedious computations.

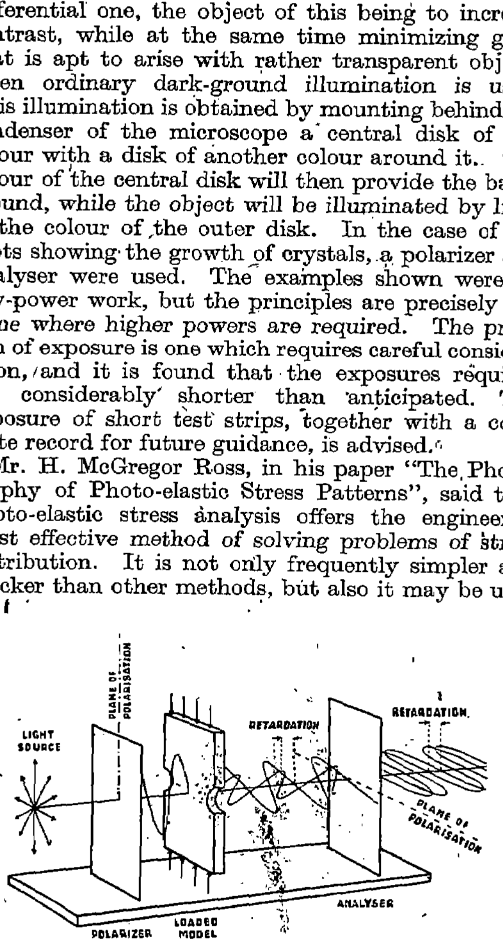

Fig. 1.

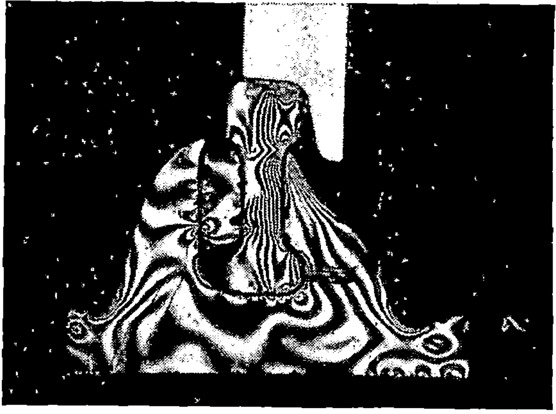

Fig. 2.

The majority of stress distribution problems may be simplified by considering the two-dimensional system of stresses in a section of the object under investigation. These stresses may be completely determined by finding the magnitude and direction of the two 'principal stresses', and photo-elastic stress analysis is particularly well suited for obtaining this information.

A transparent scale model is made of the section of the object, using a suitable plastic material. Loads which are proportional to the loads in the real object are then applied to the model, and it is viewed by polarized light in a polariscope. If a monochromatic light source is used, a pattern of light and dark lines will be seen in the model, and it is from these lines that the magnitude of the stresses may be determined. Each line may be considered as a 'contour' of stress, the difference between the two principal stresses being the same at every point along each line; the value of this difference is found by a previous simple test. The stresses in the actual object will be proportional to those found in the model.

The optical theory is shown simply in Fig. 1. Light from the source passes through a polarizer and emerges plane-polarized. The material of which the model is made has the property of becoming birefringent when stressed, so that the polarized light is split into two components on entering the stressed model. The direction of vibration of these components is the same as the directions of the principal stresses. While passing through the model, one component will travel more slowly than the other, so that it will be 'retarded' on emerging from the model. The extent of this retardation is proportional to the magnitude of the difference between the two principal stresses. The two components are combined by being passed through the analyser, and the interference effects caused by the retardation gives rise to the stress pattern observed in the model. If a white light source is used, the resulting stress pattern will consist of coloured lines, the colours being similar to those given by any interference phenomenon. Photographs in natural colours were shown of typical stress patterns.

At all points in the model where the direction of one of the principal stresses coincides with the plane of the incident polarized light, the light passes straight through the model and is cut out by the analyser. This results in a dark line—the isoclinic line—appearing in the model, from which the direction of the principal stresses may be found. If it is required to find the magnitude of each principal stress separately, a further technique is required which was not considered in this paper.

In order that these patterns may be photographed successfully, it is necessary to use a suitable polariscope. An instrument which had been found satisfactory was demonstrated, and various points in its design were discussed. With this instrument photographs had been obtained with very short exposures. Consideration was also given to the best photographic materials for this type of work.

A recent development, particularly in Great Britain, has been the combination of photo-elastic stress analysis with the technique of high-speed photography for recording sudden dynamic stresses, carried out at the Research Laboratories of Kodak Ltd. Two methods are available: in the first, a brilliant flash of very short duration is used to record a very rapidly moving phenomenon, and a photograph was shown taken in natural colour with the 'Kodatron' Speedlamp at an exposure of about 1/10,000 sec. In the second method, a cine-film, taken at a very high rate, is then projected at a normal rate so that the action is greatly slowed down. Such a film believed to be the first of its type taken in natural colour, was shown; in this, the exposures were taken at the rate of 1,000 per second. It showed the stresses found in the chair holding a railway line to the sleeper, and a 'still' from the film is shown in Fig. 2.

Prof. Bogue said, in closing the meeting, the programme must surely have demonstrated that photography is a scientific instrument capable of many and varied applications.

U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

At the annual meeting of the U.S. National Academy of Sciences held on April 27, the following officers and new members were elected:

President: Dr. Frank B. Jewett, re-elected for a further term of four years. *Home Secretary:* Dr. F. E. Wright, re-elected for a further term of four years. *Members of Council:* W. Mansfield Clark, De Lamar professor of physiological chemistry, Johns Hopkins Medical School (re-elected); Walter R. Miles, professor of psychology, Yale University School of Medicine (succeeding Prof. Oswald Veblen).

Foreign Associates: Alfonso Caso, Instituto Nacional de Antropologia e Historia, Mexico City; Sir Harold Spencer Jones, Astronomer Royal, Royal Observatory, Greenwich; Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, London; Prof. C. E. Spearman, emeritus professor of psychology in the University of London; Sir D'Arcy Thompson, professor of natural history in the University of St. Andrews; Dr. H. J. van der Bijl, chancellor of the University of Pretoria.

New Members of the Academy: L. H. Adams, Geophysical Laboratory, Carnegie Institution of Washington; Dr. A. Adrian Albert, assistant professor of mathematics, University of Chicago; Prof. J. W. Beams, professor of physics, University of Virginia; Prof. A. F. Buddington, professor of geology, Princeton University; Dr. Leonard Carmichael, president of Tufts College, Medford, Massachusetts; Prof. W. H. Chandler, professor of pomology, University of California, Los Angeles; Prof. E. J. Cohn, professor of biochemistry, Harvard Medical School; Prof. J. N. Couch, professor of botany, University of North Carolina; Prof. Th. Dobzhansky, Columbia University; Prof. Lee A. DuBridge, professor and chairman of the Department of Physics, University of Rochester; Dr. L. C. Dunn, professor of zoology, Columbia University; Prof. Wallace O. Fenn, professor of physiology, University of Rochester; Dr. Paul D. Foote, director of research and executive vice-president, Gulf Research and Development Company, Pittsburgh, Pa.; Prof. L. P. Hammett, professor of chemistry, Columbia University; Prof. William V. Houston, professor of physics, California Institute of Technology, Pasadena, California; Prof. Walter P. Kelley, professor of agricultural chemistry, Citrus Experiment Station, Riverside, California; Dr. Warfield T. Longcope, professor of medicine, Johns Hopkins University; Dr. E. K. Marshall, jun., professor of pharmacology and experimental therapeutics, Johns Hopkins Medical School; Dr. L. Michaelis, Rockefeller Institute for Medical Research, New York; Dr. W. Albert Noyes, jun., professor of physical chemistry, University of Rochester; Prof. O. H. Robertson, professor and head of the Department of Medicine, University of Chicago; C. G. Rossby, University of Chicago; Prof. Calvin P. Stone, professor of psychology, Stanford University; Dr. C. V. Taylor, professor of zoology, Stanford University; Dr. H. B. Vickery, in charge of Biochemical Laboratory, Connecticut Agricultural Experiment Station, New Haven, Connecticut; Dr. V. K. Zworykin, director of the Electronic Research Laboratory, RCA Manufacturing Company, Camden, N.J.

Presentation of Medals

The following five gold medals were presented:

Henry Draper Medal for 1942, to Ira Sprague Bowen, of the California Institute of Technology, Pasadena, California, in recognition of his contributions to astronomical physics; more especially his researches on the spectra and chemical composition of the gaseous nebulæ. Best known and one of Dr. Bowen's most brilliant accomplishments was his discovery of the nature of 'nebulium' lines, a most difficult problem solved by him after the ablest spectroscopists had struggled with it for three quarters of a century and had failed. This discovery and the results of his subsequent researches yielding the identification of numerous other forbidden lines in nebular and stellar spectra constitute some of the most important advances in astrophysics within recent years.

The Draper Medal is provided by the income from a trust fund given to the Academy in 1883 by Mrs. Henry Draper in memory of her husband, a former member of the Academy. It is awarded for investigations in astronomical physics. The present award is the twenty-sixth.

Agassiz Medal for 1942, with accompanying honorarium of 300 dollars, to Columbus O'Donnel Iselin, II, director of the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, in recognition of his studies of the Gulf Stream system, for his leadership in the development of a general programme of the physical oceanography of the North Atlantic, and for his distinguished direction of the activities of the Woods Hole Oceanographic Institution, both in peace and in time of war.

The Agassiz Medal is provided by the income from a trust fund given to the Academy by Sir John Murray in 1911 in honour of Alexander Agassiz. It is awarded for contributions in the science of oceanography. The present award is the nineteenth.

Daniel Giraud Elliot Medal for 1935, with accompanying honorarium of 200 dollars, to Edwin H. Colbert, of the American Museum of Natural History, New York City, in recognition of his "Siwalik Mammals in the American Museum of Natural History", published in the *Transactions of the American Philosophical Society* in October 1935.

Daniel Giraud Elliot Medal for 1936, with accompanying honorarium of 200 dollars, to Robert Cushman Murphy, of the American Museum of Natural History, New York City, in recognition of his "Oceanic Birds of South America", published in two volumes in 1936.

The Elliot Medals are provided by the income from a trust fund given to the Academy by Margaret Henderson Elliot in honour of her father, Daniel Giraud Elliot, in 1917. The award to Dr. Colbert is the eighteenth Elliot Medal to be presented by the Academy; and that to Dr. Murphy is the nineteenth. The deed of gift of the Elliot Fund calls for an annual award for the most meritorious work published during that year upon some branch of zoology or palæontology.

John J. Carty Medal and Award for the Advancement of Science for 1943 (medal and 4,000 dollars), to Edwin Grant Conklin, of Princeton University, Princeton, New Jersey, in recognition of his services to science as zoologist, cytologist and embryologist; philosopher, teacher and man of science; student of life and of growth from lowliest beginnings to highest consummation.

The Carty award is provided by the income from a trust fund given to the Academy in 1930 by the American Telephone and Telegraph Company, in honour of John J. Carty, a former vice-president of that company, who was a member of the Academy. The medal and monetary award, made not oftener than once in every two years, are awarded to an individual for noteworthy and distinguished accomplishments in any field of science coming within the scope of the charter of the Academy. The present award is the fourth to be presented by the Academy.

NEWS and VIEWS

Rothamsted Experimental Station: New Director

IN a few months time, Rothamsted, the world's oldest and most famous agricultural research station, will celebrate the centenary of its foundation and another period of useful activity will begin, though under a new director, Dr. William Gammie Ogg. Dr. Ogg is the son of a farmer and is known to farm successfully himself, so that he may be described as close to the soil. It is known that in future Rothamsted will concentrate more closely on soil problems, extending what has been discovered at Harpenden and Woburn to other types of soil, so that the new director is appropriately a soil specialist. Dr. Ogg studied at Aberdeen under Japp, began research in agriculture there, but on the outbreak of war in 1914 became a chemist in the explosives industry, ending up as chief chemist and works manager at Greetland. After 1918 he came back to agricultural research and spent a year in Canada and the United States. On his return he went as a research student to Christ's College, Cambridge; and for four years he was technical adviser to Messrs. Chivers.

In 1924 the soil claimed Dr. Ogg once more, and he was appointed advisory officer in soils at the Edinburgh and East of Scotland College of Agriculture, where he stayed for six years studying soils in various parts of the world. When the Macaulay Institute for Soil Research was founded in 1930 at Craigiebuckler, Aberdeen, he became the first director. In the ensuing decade Dr. Ogg has gathered round him a band of young and keen workers, so that in a short time the Institute has achieved considerable fame in connexion with the many problems of soil survey. The work has involved the development of a technique of quick analysis of the minor constituents of the soil by modern physical methods. His services have been extensively used by the Agricultural Research Council, and he has published quite widely. Dr. Ogg will bring to Rothamsted a full knowledge of the soil and its many problems; he is a proved administrator and leader.

Institute of Fuel: Melchett Medal

The Melchett Medal for 1943 of the Institute of Fuel has been awarded to Dr. E. S. Grumell. This medal is the highest award in the gift of the Institute of Fuel and is being presented to Dr. Grumell in recognition of the outstanding work tending to the economical use of fuel which he has done over a long period. Dr. Grumell has, for many years, been head of the coal research laboratories of the Imperial Chemical Industries, Ltd., and the research and experimental work carried out by him, having been published for the benefit of the community as well as for that of his company, has resulted in improving the design of many combustion appliances and, consequently, in the saving of large quantities of fuel. In addition, Dr. Grumell was appointed chairman of the Fuel Efficiency Committee set up by the Mines Department and later carried on under the Ministry of Fuel and Power. The work of that Committee has undoubtedly contributed very largely to the more economical use of fuel in Great Britain, thus enabling our output of coal to meet the essential demands of both industrial and domestic requirements. The medal will be presented at the annual conference of the Institute of Fuel to be held in October next.

Coal as the Basis of the War Effort

The eighth report of the Select Committee on National Expenditure for the session 1942–43, dealing with fuel and power, cannot but arouse further misgiving in regard to the fuel situation in Great Britain. The Select Committee thinks it would be unwise to look forward to any increase in production in 1943. The substantial increase in output on which the Government counted in the White Paper on Coal last year is illusory, and the fact that in the event of a European front being formed it may well become necessary to export increased quantities of coal makes economy the more imperative. In recommending therefore that, in addition to all consumers being emphatically and regularly reminded of the need for stringent economy, and continued attempts to bring home to that small section of the miners guilty of avoidable absenteeism how much really depends on them, the Select Committee reiterates that coal is the very foundation of the total war effort. The general conclusions have a bearing of the highest importance upon the war activities of the nation, and are stated in terms which admit of no misunderstanding. The annual loss, due to normal wastage, of some 20,000 or more men, to which the labour force available in the industry is subject, is expected to be offset during the present year by the entry of 'optants' into the industry and by upgrading to the extent of some 4,000 men, leaving a net loss of about 16,000 men. The total number of men engaged in the industry will therefore inevitably be reduced during the next twelve months below the lowest level at which it has stood since August 1941. Moreover, no further relief can be expected from expedients such as the return of miners from the Home Forces, which have recently made good normal annual wastage.

Unless, therefore, the reduced production consequent upon the diminished labour force is counterbalanced by new factors capable of increasing the output of available labour, a dangerous decline in coal production must occur, with repercussions on the price of coal and the output and cost of munitions. The Committee considers that the evidence does not suggest that any such new factors are likely to make themselves felt, and is clearly not satisfied that the introduction of a comparatively novel type of coal-getting machines in Great Britain or concentration are likely to be effective factors in increasing production. Moreover, while recommending that new experiments should be tried to diminish delays in dealing with cases of avoidable absenteeism, it is pointed out that past experience does not encourage optimism as to a solution of this intractable problem. The Select Committee recommends, it is true, that efforts should be made to accelerate production and delivery of machinery urgently required for further mechanization, and that investigations should be continued to achieve further fuel economies by some industrial users. The fuel economy campaign, both domestic and industrial, should be continued without a break and the public advised on the order of priorities of economies in fuel; in particular, the need for greater economies should be impressed on gas and electricity slot-meter users. The aid of managements and miners should be sought in remedying complaints about inferior fuels.

These recommendations are clearly no more than palliatives. The Select Committee is convinced that a serious reduction in output is likely unless measures of a more far-reaching character than any hitherto proposed are found and put into operation without delay. Important as are the Committee's observations on education and guidance of public opinion and on economy by the consumer, the whole trend of the report strengthens the argument for a great expansion of research into the efficient use of coal raised in a recent report of the Parliamentary and Scientific Committee (see p. 709). From that alone is there the prospect of the real fundamental developments to which the Select Committee looks, albeit it must be admitted that such research is more likely to be a long-range affair and unlikely to yield results which will serve the immediate purpose of relieving the present fuel shortage in Great Britain.

Relaxation Methods in Engineering Mathematics

Prof. R. V. Southwell delivered the Bakerian Lecture of the Royal Society on June 17, taking as his subject, "On Relaxation Methods: a Mathematics for Engineering Sciences". Engineering calls for computations (for example, of stresses) which need not be very exact, but which must not be restricted to particular shapes of boundary. Its needs are not always met by orthodox mathematical analysis, which in many problems offers a precision that cannot be utilized (by reason of the unavoidable uncertainty of physical data) at the cost of limitations that are felt at every turn. On this account solutions are often sought experimentally, use being made of mathematical analogies (for example, of fluid velocities with electric currents in a conducting sheet).

Relaxation methods—a development of the past eight years—aim at providing engineering science with a mathematics more suited to its needs. Computation is made a tentative process, akin to the 'hand-scraping' technique whereby, in engineering, a part is brought to close conformity with a gauge or template. Attention is fixed upon the data of the problem (for example, the loads applied to a structure); and the point of view is adopted that in practice all such data have an unavoidable margin of uncertainty, and therefore 'exact' has no more meaning as applied to computations than it has as applied to measurement. At every stage in a computation effected by relaxation methods, values are recorded of the 'residuals' (that is, 'loads not yet accounted for'). When all such values lie within the margin of uncertainty, further computation is not only unnecessary but also meaningless. Problems concerned with systems of finite freedom have been discussed in earlier lectures: Prof. Southwell dealt in the main with problems governed by partial differential equations in two independent variables. Most of the standard equations have been solved, and without restriction to particular shapes of boundary. Current work is concerned with equations which are non-linear and so present special difficulties.

Welfare of Laboratory Animals

The Universities Federation for Animal Welfare (U F A W), temporary address, 284 Regent's Park Road, Finchley, London, N.3, as a result of recent correspondence with a number of workers engaged in experiments on animals, finds a widespread desire for experience to be pooled so as to enable the maximum of consideration to be shown for laboratory animals. With the view of helping to give effect to this feeling the Federation has supplied to 130 laboratories, on request, a copy of the recent book "Veterinary Anæsthesia", by Prof. J. G. Wright. At the suggestion of a number of research workers, the Federation is proposing further to compile information relating to (1) anæsthesia of rats, rabbits, guinea pigs and other animals not covered by Prof. Wright's book; (2) methods of killing laboratory animals; (3) living conditions, housing, diet, etc., and to invite a small number of experienced men to act as a panel for approving or amending the resulting compilation. U F A W would welcome any views or suggestions relating to these proposals, addressed as above.

Institution of Electrical Engineers: Annual Report

SOME of the salient features of the report for the year 1942–43 of the Council of the Institution of Electrical Engineers may be cited as follows. At the twelve months ending March 31, 1943, the total membership numbered 22,315, and of those there were 11,097 corporate members; 2,106 elections to all classes of membership were made during the period. During the same year 534 meetings were held in London and at the local centres. The Wireless Section held 12 meetings, the Measurements Section 8, the Transmission Section 8, the Installations Section 9; and there were six informal meetings. There are nine students sections, and extensive programmes have been arranged by the respective committees during the year.

A number of interim reports has been submitted to the Council by the various special committees and panels appointed to study post-war problems, among the subjects dealt with being "Service Arrangements in Houses, Flats and other Buildings", "The Availability of Electricity Supply", "Domestic Electrification" and "Telecommunication Engineering". Reports on education and training for engineers and the organization of post-war electrical research have since become available. The subject of standardization has received consideration, and papers relating to this aspect of industrial electrical instruments, single-circuit overhead lines up to 33 kV., and integrating electricity meters have been presented. A fourth, on the standardization of motor dimensions, has since been published. The report also deals with various phases of the Institution's war effort, with joint activities with other institutions, and with the subject of education.

Institute of Fuel: Students' Medal

To encourage the preparation of papers by students of fuel technology, the Council of the Institute of Fuel has decided to make an annual award of a medal, together with a prize consisting of books and/or instruments, to the value of £5. The award will be made annually for a paper submitted by a student member of the Institute or by a student of any university or technical college in the United Kingdom less than twenty-five years of age, dealing with some subject relating to the preparation or utilization of fuel or allied subjects. Papers must be submitted under a *nom de plume*, the name and address of the author being enclosed in a sealed envelope and sent with the paper, and must be received by the Secretary of the Institute, 30 Bramham Gardens, London, S.W.5, on or before September 1 in any year. In judging the papers submitted, consideration will be given to (*a*) subject-matter; (*b*) evidence of analytical power and logic; (*c*) construction of paper in so far as it gives evidence of an orderly mind and shows continuity of argument with an orderly development of the theme; (*d*) English.

Samuel Hahnemann (1755–1843)

SAMUEL CHRISTIAN FRIEDRICH HAHNEMANN, the founder of homœopathy, was born at Meissen in Saxony on April 10, 1755. He studied medicine at Leipzig and Vienna, and after qualifying in 1779 at Erlangen, settled in Leipzig, where he translated Cullen's "Materia Medica" into German. He first set forth his doctrine of similars in Hufeland's *Journal* in 1796 and elaborated it in his chief work entitled "Organon der rationellen Heilkunde" in 1810. The characteristic theories on which the system was founded were first 'the doctrine of signatures', according to which diseases or symptoms were cured by the drugs which produce similar morbid changes upon the body, and secondly the view that the action of drugs was intensified by the administration of infinitesimally small doses. He died in Paris on July 2, 1843.

The Night Sky in July

NEW moon occurs on July 2d. 12h. 44m. U.T. and full moon on July 17d. 12h. 21m. The following conjunctions with the moon take place: July 4d. 08h., Jupiter 2° N.; July 6d. 16h., Venus 0·4° S.; July 24d. 23h., Mars 4° N.; July 28d. 07h., Saturn 3° N. In addition to the above occultations, Venus is in conjunction with Regulus on July 6d. 19h., Venus 0·3° N. The following occultations of stars brighter than magnitude 6 occur: July 6d. 16h. 12·6m., α Leo (*D*); July 6d. 17h. 27·5m., α Leo (*R*); July 13d. 21h. 05·7m., 49 Lib (*D*); July 27d. 2h. 29·0m., 264 *B.* Tau (*R*); July 27d. 4h. 15·0m., α Tau (*D*); July 27d. 5h. 23·6m., α Tau (*R*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance respectively. Mercury is in superior conjunction on July 18 and is unfavourably placed for observation. Venus can be observed as an evening star during the month. The planet sets about 2h. 10m. after the sun at the beginning of the month and about 45m. after the sun at the end of the month. Mars moves from the constellation of Pisces to Aries during July. A remarkable effect is produced by its movement in north declination. At the beginning and end of the month it sets at nearly the same time—about 13h. 40m. Jupiter is in superior conjunction with the sun on July 18. Saturn, in the constellation of Taurus, is a morning star, rising at 1h. 50m. and setting at 17h. 50m. in the middle of the month. Times are given approximately for the latitude of Greenwich. The earth is at aphelion on July 4, being a little more than 94½ million miles from the sun on that date.

Announcements

THE Lord President of the Council has promoted Dr. B. A. Southgate to be acting director of water pollution research in the Department of Scientific and Industrial Research, to fill the vacancy arising from the appointment of Dr. A. Parker to be director of fuel research.

FIVE Turkish undergraduates have just arrived in Britain to study British machine, electrical and mining engineering with scholarships given by the British Council. They are Mustafa Necati Ozişik, Turhan Necat Çetinkale, Halil Sancak, Cavit Erginsoy and Fuat Mericelli. With them is Mr. Mehemet Ali Pamir, an inspector from the Turkish Ministry of Economics, who is taking a course of public administration at the London School of Economics.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron-Microscopic Examination of Tissues

To obtain a better insight into various fundamental vital processes, for example, the stimulation of nerves and the contraction of muscles, we require a more thorough knowledge of the morphological substratum than can be acquired by the use of visible-light microscopy and various indirect methods for the study of submicroscopic structures. The electron microscope with its great resolving power affords theoretical possibilities of making direct studies of sub-microscopic structures of almost molecular sizes.

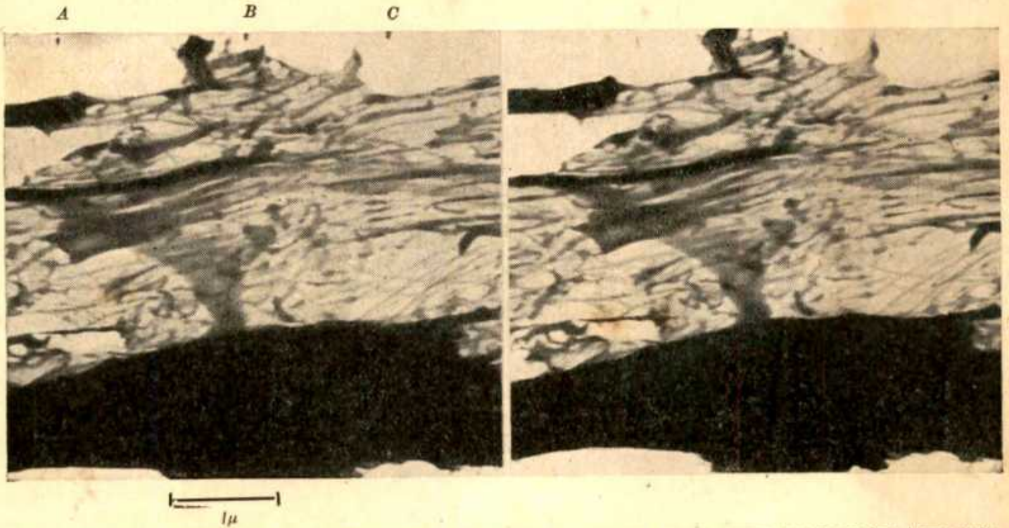

Fig. 1. ELECTRON-MICROSCOPIC STEREOPHOTOGRAPH OF A SKELETAL MUSCLE FIBRE, FIXED ACCORDING TO ALTMANN'S TECHNIQUE OF FREEZING-DRYING. MAGNIFICATION 15,000, ACCELERATION-VOLTAGE 60 KV., THICKNESS OF SECTION WHERE THINNEST ABOUT 20 mμ.

The lack of a suitable method of preparing the tissues has hitherto been an obstacle to the practical use of the electron microscope for consistent studies of tissues. Contrary to what is the case in histology, this method can be limited to the preparation of very thin objects (0·05 μ thick), since the tissues themselves possess sufficient contrasting factors, thus making staining of the tissues superfluous. These contrasting factors—differences in density, an irregular distribution of light and heavy atoms, variations in the thickness of the specimens—exclude *inter alia* the use of the common fixing methods. Altmann's technique of freezing-drying is the method that best fills the requirements.

The upper limit of the thickness of the specimens is 0·05 μ and is determined *inter alia* by the chromatic error, which renders impossible a fully profitable use of the resolving power of the electron microscope when the specimens are thicker, even though the electrons, by the use of high acceleration-voltage, can penetrate considerably thicker objects.

In order to obtain this thickness of the specimens a cutting method has been elaborated, the principle of which is that an ordinary microtome slip is cut afresh, so cutting away within a limited area most of the thin section. This thin part is supported by the surrounding thicker parts during the handling of the section.

Fig. 1 is a stereophotograph (magnification 15,000) of a skeletal muscle fibre from a guinea pig, fixed according to Altmann's technique of freezing-drying. The picture was taken with an electromagnetic electron microscope with a high resolving power constructed at the Research Institute for Physics of the Royal Academy of Sciences, Stockholm, by Prof. Manne Siegbahn. In spite of the low acceleration-voltage, 60 kV., the electrons penetrate the thin part of the section very well, the thickness of that part presumably being only about 20–30 mμ. Only small parts which are properly supported by adjoining thicker parts can remain intact when so thin.

The detailed interpretation of the electron-microscopic pictures must at this stage be subject to

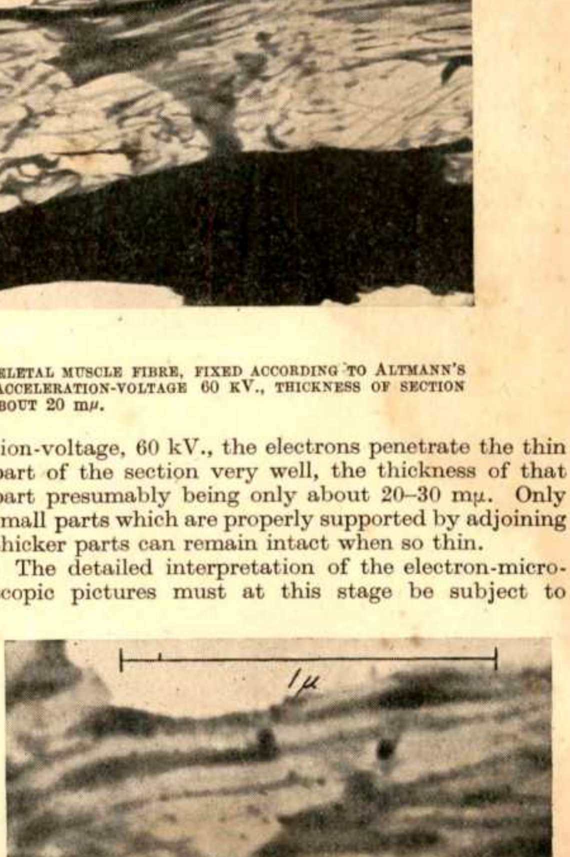

Fig. 2. DETAIL OF FIG. 1, MAGNIFICATION 50,000 TIMES.

reservations. Stereoscopically the folding stands out beautifully in the thin part of the section. The thickness of the object varies somewhat and the different resolving power in the thicker and thinner parts of the slip is readily observed. A fibrillar structure can be seen with the thinnest fibres 5–10 mμ thick.

Striation with some fibres either running more regularly in a longitudinal direction or arranged as an irregular network can also be traced between the marks *A* and *B* and *B* and *C*. Other distinct fibres run in a uniform manner through the different segments.

In Fig. 2, which is a detail of the same thin section taken with a high resolving power and enlarged 50,000 times, the former fibres are seen to be divided into lighter and darker segments, whereas the latter are not divided in that manner. One obtains a strong impression of a complicated structure, which is in good agreement with optical polarization and röntgenometric observations, but a direct study of which will lead considerably farther than to the simple scheme constructed on the basis of the indirect methods.

The figures must, for the time being, be regarded merely as demonstrations of the value of a method that is still being elaborated and as good examples of what can be found by the use of the electron-microscope, which on the whole is remarkable for its very simple and neat construction.

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Royal Academy of Sciences, Stockholm.
Anatomical Institute,
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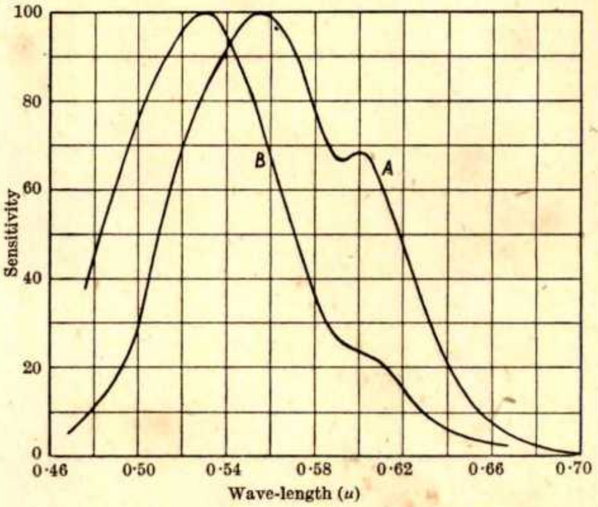
Stockholm.

Spectral Sensitivity of the Retinal Receptors

RECENT measurements by Granit[1] on the electrical response of individual receptors in the retinæ of various animals—frog, rat, cat, snake, etc.—have shown that the spectral sensitivity of the cones may vary from red-sensitive receptors with their maximum response at a wave-length of 0·60 μ to blue-sensitive elements with their maximum at 0·45 μ. Granit has found four main groups of cones, the largest group (dominators) having a maximum sensitivity at about 0·560 μ, and the three smaller groups (modulators) with maxima in the ranges 0·58–0·60 μ, 0·52–0·54 μ and 0·45–0·47 μ. Without considering the pros and cons of Granit's dominator-modulator theory, the question arises why, if the cones in the human retina have similar properties, some evidence of their individual sensitivity curves is not obtained from measurements of the luminosity curve by human observers.

The answer must be, in part, that any visual observation necessarily involves a number, and generally a very large number, of receptors, because of the area of the retina covered by the usual size of the photometric field, and because of the involuntary eye movements which take place even when the observer is gazing steadily in one direction. But it also appears that luminosity measurements have not, with one or two exceptions, been carried out under the limiting conditions of observation which might be expected to reveal the composite nature of the luminosity curve. Observations by Sloan[2] have shown that the spectral sensitivity curve of the fovea at low intensities develops a hump on the red side of the curve and this has also been observed recently by Walters and Wright[3]. This hump has been analysed by Forbes[4] on the assumption that it is due to the more prolonged functioning of the red receptors than the green receptors as the illumination is reduced.



In an attempt to produce still greater isolation of the red response, I have recently measured the luminosity curve at low brightness values for foveal and parafoveal vision for the dark-adapted eye, using a pair of small circular spots of light as the matching fields. Two sizes of test object have been employed, with angular diameters of 20′ and 5′ respectively. Typical results for one brightness level for the larger test object are shown in the accompanying diagram, both for foveal vision (curve *A*) and for a retinal area 2° from the fovea (curve *B*). The curves record the sensitivity of the retina at each wave-length, the sensitivity being proportional to the inverse of the energy required in one spot of light to produce a brightness equal to that of a similar spot illuminated by light of a given wave-length at a fixed brightness. The wave-length of the comparison patch was chosen to be 0·63 μ, so as to aid foveal fixation, while its brightness, for the experiment illustrated in the diagram, was $5 \cdot 8 \times 10^{-6}$ ergs per square degree per second, when expressed in terms of the energy density of the 0·63 μ radiation on the retina. (The ordinary photometric units have very little meaning at these levels owing to the Purkinje effect.)

The interesting features of curve *A* are the absence of any Purkinje shift of the curve as a whole, which may be attributed to the absence of rods at the fovea, and the appearance of the small peak at a wave-length of 0·60 μ, which provides striking evidence of the composite nature of the luminosity curve. If the peak is the result of the simple addition of the sensitivity curves of the red and green processes of the Young-Helmholtz theory, then the maximum of the red response curve must occur at a wave-length slightly longer than 0·60 μ. The development of the peak at low brightness levels presumably means that the green receptors reach their limiting sensitivity at a higher brightness than the red receptors.

Extension of the range of observing conditions to lower brightness levels and to the smaller pair of test objects has not resulted in the peak becoming more pronounced. At higher levels and with larger fields, the peak reduces to a hump and then disappears altogether.

Curve *B* shows the marked difference in the phenomenon when a mixed rod-cone area of the retina is used, compared to a pure cone area. There is a decided shift of the curve as a whole towards the blue end of the spectrum, and the hump which appears in the same region of the spectrum as the peak in curve *A* now occurs much lower down the curve. This is a result of the greater sensitivity of the rods compared to the cones at the brightness level being used.

These experiments give some promise that, under still more varied conditions of observation and with normal and colour defective observers, some useful information should be obtained which can be correlated with electrophysiological results. A fuller account of the present work will be given when there has been opportunity for further experiments on these lines.

My thanks are due to the Medical Research Council for assistance with an expenses grant.

W. D. WRIGHT.

Imperial College of Science,
London, S.W.7.
June 3.

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[1] Granit, R., NATURE, 151, 11 (1943).

[2] Sloan, L. L., *Psych. Mon.*, 38 (1928).

[3] Walters, H. V., and Wright, W. D., *Proc. Roy. Soc.*, B (in course of publication).

[4] Forbes, W. T. M., *Amer. J. Psychol.*, 41, 517 (1929).

Physiology of Colour Vision

MR. WILLMER has replied[1] to Prof. H. Hartridge (and incidentally to me, when I had made the same point in discussion) that the impossibility of obtaining greens and yellows by mixtures of extreme red and blue might be due to the impossibility of so obtaining high enough intensities to evoke a yellow or green sensation, rather than indicating the incorrectness of his (Mr. Willmer's) theory. Since then, the following simple and, I believe, crucial, experiment was tried.

Light passing through a yellow or green filter illuminated one side of a plaster Ritchie prism and was adjusted to give a reasonably bright and subjectively indubitable yellow or green. By illuminating the other side of this block with white light from a standard lamp until a match was obtained, its brightness was found to be 1·equivalent foot candle. Such heterochromatic photometry, though sometimes difficult for the inexperienced, is well known to be possible and to give reasonably consistent results. For example, mixtures of colours, each matched with a white and added to each other, give a heterochromatic match with a white having the physical intensity of the sum of the whites which matched each separately; and although two different colours never look exactly the same, it is possible, within narrow limits, to say whether one is darker or brighter than the other. Flicker photometry can also be used to give more exact results.

A lamp in a box the front of which was covered half with a red filter transmitting only light longer than 600 mμ and half with a blue filter transmitting only below 500 mμ was then substituted for the white light. No difficulty was found in obtaining a brightness-match between the purple light falling from this on to the prism and the yellow or green by varying the distance of the red-and-blue light box. Intensities equal to those of a 'good' yellow or green can thus easily be obtained from a mixture of red and blue. By rotating the mixed-light box slightly about the axis joining the filters, its lamp could be made to shine mainly through one or other filter and the relative proportions of the two falling on the Ritchie prism altered. The colour changed from red to blue through a series of lilacs, mauves and purples, in conformity with classical data and theories of colour vision, and at no stage did it approach a match with the light from the yellow or green filter, or even look yellow or green.

Subjective judgments of colours, seen in isolation, instead of *colour matches*, have been considerably used by Mr. Willmer, and are notoriously unreliable, partly on account of selective colour fatigue and partly because our judgments of colours are relative to the general colour of our perceptual field at the time. These two effects can be separated by seeing which effects are peculiar to the colour-adapted eye, that is, are selective adaptation of the retina, and which are shared with the unfatigued eye. Thus, if we look for long at a landscape through a red filter with one or both eyes and then remove the filter, the landscape looks strongly tinged with green to the fatigued eye or eyes; this is a mixed retinal and central or psychological effect. If we look at the scene through one eye with the filter, keeping the other eye closed, for some time, then remove the filter, close that eye, and open the other, the landscape looks faintly tinged with green; this is presumably a central or psychological effect. It is known that every visual perception—whether of size, movement, position, or distance—is largely influenced by the framework of the rest of the visual field, and that the discriminatory abilities of the eye are best studied by comparative, not absolute, judgments; hence the value of colour matches in the present instance as a crucial test.

The red and blue used in the present experiments had photopic/scotopic ratios of approximately 12 : 1 and 0·15 : 1 respectively, so that any ratios between these two could be obtained, covering very easily the regions required for yellows and greens in Mr. Willmer's theory (namely, about 4 : 1 and 1 : 1), and the attainment of a brightness equal to that of a good yellow or green separately produced showed that lack of brightness was not the trouble; yet a match with a yellow or green was impossible. Indeed, it is known that a red-blue mixture (purple) is actually complementary to green.

Another objection to Mr. Willmer's theory is the sensation of white. On the traditional theories the reason why white does not appear in the spectrum is that it requires a mixture of three variables which do not appear in the required proportions in the spectrum. But on Mr. Willmer's theory there are only two variables, rods and cones, and as white represents, in his view, a 1 : 1 ratio of these responses, a spectral wave-length of about 560 mμ (greenish-yellow) should look white. Mr. Willmer again contends that the intensities obtained by spectral lights are not high enough, and points out that such a wave-length, at extremely high intensities, does indeed look white. But he overlooks the fact that very good whites can be obtained from mixtures of three spectral hues, or from a continuous spectrum, at much lower intensities where no single spectral hue,[1] or mixture of red and blue, looks white. The matching method above described again shows the failure of his theory.

K. J. W. Craik.

Psychological Laboratory,
University of Cambridge.
May 30.

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[1] Nature, 151, 632 (1943).

Temperature of the Solar Corona

It is quite possible that a temperature of the order of 2,300,000° K., mentioned in Dr. A. Hunter's article on this subject[1], may be maintained in the solar corona by collisions of atoms, accelerated from distant regions by the gravitational field of the sun. It is difficult to estimate the resulting temperature without exact knowledge of coronal density, but if the radiation losses of the corona are neglected and equipartition of kinetic energy between ions and electrons is assumed, calculation gives a temperature of the order 20,000,000° K. for atoms of iron, accelerated from infinity to the surface of the sun. Radiation losses increase with the density and might be considerable in the inner corona, and equipartition of the energy might not be reached, so that the ionization maintained in the inner corona might be of the correct order, as required by Edlén's proposals; but there is a possibility that in a more distant region there will be a layer of higher kinetic temperature and that the temperature decreases to that of the surface of the sun, as the sun is approached.

The question arises whether the sun is trapping enough matter to produce the observed density in the corona. According to my investigations, there might be an appreciable evaporation of finely divided interplanetary matter in the vicinity of the sun. Under gravitational force only, the resulting cloud of vapour would follow the original path of the solid particle, and very little matter would be trapped. However, more complicated forces are in action on single atoms. There would be a repulsive force due to the pressure of radiation, but as the atoms would be ionized by the photo-effect of the ultra-violet solar radiation and so become transparent to the radiation responsible for the pressure, this force becomes inoperative soon after the evaporation of the particles, and the remaining forces would be due to the gravitational, magnetic and electric fields. If the magnetic field is sufficiently strong, the path of a charged particle becomes a spiral, which follows magnetic lines of force and thus in most cases ends on the surface of the sun. As the magnetic field of the sun is fairly strong in its vicinity, it seems possible that the amount of matter so trapped would be sufficient to produce the observed density of the corona.

The variations in the shape, and intensity of the corona and its line spectrum, which closely follow the sunspot cycle, may be explained tentatively by the variation of the sun's magnetic field over sunspot regions, and so by the amount of matter trapped. There might be a marked escape of high-speed electrons from the corona, and considerable electric fields may develop. These, together with the forces due to the diamagnetism of the ions, may complicate considerably the theory of the corona. More detailed results will be published elsewhere.

I should like to thank Dr. A. Hunter for valuable suggestions and criticism.

V. Vand.

32 Temple Fortune Hill,
London, N.W.11.

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[1] Hunter, A., Nature, 150, 756 (1942).

Rheological Series

A remarkable series of changes in rheological properties may be observed when 10 gm. of powdered Surrey fullers' earth are well mixed in a mortar with 170 gm. of commercial sodium silicate solution (for example, *P.* 84 supplied by I.C.I., Ltd.).

At first, the mixture is a viscous fluid-like treacle, but it soon begins to thicken. After about 15 minutes, it has the consistency of warm pitch, and after half an hour signs of elasticity appear; the mixture shakes like a jelly when the mortar is tapped, but it still flows quite readily. At this stage, the gel is torn when strongly stirred with the pestle, yet the pieces will flow together and coalesce. The material can be formed into balls which bounce like rubber when thrown on to the ground. If left on the bench they flow to form circular disks. These become less fluid and more brittle, until, after standing overnight, they are as brittle as toffee. The glass-like material which is eventually formed cements glass microscope slides strongly together.

The changes take place quite slowly and every stage in the series fluid-plastic-elastic can be studied one after another.

Other rheological series which come to mind are pitch over a temperature range, plastics containing different proportions of plasticizer, clays with different moisture contents, and so on, but the series described seems to show a wider range of rheological phenomena than most of the other series.

It is suggested that rheological series of this kind might be useful in testing the validity of two- or three-dimensional diagrams which are designed to show the relationship between the different rheological phenomena.

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The Cedars, Bath Road,
Taplow, Bucks.

H. W. J. Hathaway.

The Fullers' Earth Union, Ltd.,
Redhill, Surrey.
May 22.

Paraxanthine as a Natural Antithyroid Substance

Many substances have been found to have antithyroid activity in the vertebrate body, some of them natural constituents of the body. But it has never been clear to what extent these substances exert their antithyroid properties in normal life. In this letter we report some results which have led us to the conclusion that the basal metabolic rate is normally controlled in the rat not by the concentration of the thyroid secretion in the internal medium alone but by interaction between this secretion and an antithyroid substance which we have identified as paraxanthine (1 : 7-dimethylxanthine). The results also give some indication of the nature of this interaction.

In a previous paper[1] it was shown that the temperature - heart-rate curve of the winter frog's heart could be altered to the form typical of a summer frog's heart by adding thyroxine to the medium in which the heart was beating. Further work showed the presence in ox and whale liver and in human urine of a substance which had the opposite, antithyroid, effect—conversion of the summer form of the curve into the winter form. This action was found to be extremely consistent both in the effect produced and in the quantity of the extract required to neutralize a given quantity of thyroxine. In addition, the heart is extremely sensitive to the presence of the antithyroid substance. We thus found that the action could be used as a very reliable and sensitive biological test for the active substance. Less than 0·1 µgm. can be readily estimated.

By use of this test the substance was fractionated from the extracts and identified. The substance in urine was concentrated and finally isolated by successive precipitation with cupric chloride, mercuric chloride and auric chloride under carefully controlled conditions, the precipitate with each salt being collected, washed and decomposed with hydrogen sulphide before precipitation with the next salt. The crude product was purified by recrystallization first of its picrate and then of the regenerated substance itself. The pure product had a melting point of 295°. Its identity as paraxanthine was confirmed by analysis and by a direct comparison with a sample of paraxanthine which had been synthesized by a modification of Fischer and Ach's method[2,3]; the natural and synthetic paraxanthines had the same melting points (mixed and unmixed), and identical absorption spectra, the latter being kindly measured for us by Dr. C. B. Allsopp.

It should be emphasized that the above laborious isolation of the paraxanthine was due to the fact that the identity of the antithyroid factor was obviously unknown when this treatment was worked out: paraxanthine can be isolated more expeditiously from urine by the method of Kruger and Salomon[4].

Paraxanthine was also isolated similarly from an aqueous extract of papainized whale liver.

Synthetic paraxanthine was found to give precisely and quantitatively the same action on the frog's heart as the active substance in the extracts—0·22 µgm. per l. of either the natural or synthetic substance will neutralize 1 mgm. thyroxine per l. We have tested on the heart a number of substances related to paraxanthine (caffeine, theobromine, theophylline, l-methylxanthine, xanthine, adenine, guanine) and find none to have more than 1/1,000 of the activity of paraxanthine. We think there can be no doubt that the active substance of the extracts is paraxanthine.

In another way the actions of the natural and synthetic substances on the heart are identical. We have found that for any given concentration of thyroxine there is an optimum concentration of paraxanthine that gives complete neutralization. If this optimum concentration is exceeded, the effect diminishes until with double the optimum concentration there is no effect, the form of the curve being the same as with thyroxine alone. Thus, if a heart is giving the summer form of the curve in a medium containing thyroxine 1 mgm. per l., and is then made to give the winter form by adding to the medium paraxanthine 0·22 µgm. per l., it can be made to give the summer form again by raising the paraxanthine concentration to 0·44 µgm. per l., the same thyroxine concentration being retained throughout. Further, the heart again returns to the winter form if the thyroxine concentration is now raised to 2 mgm. per l., while the paraxanthine is kept at 0·44 µgm. per l. The reversal can be repeated by alternately raising the paraxanthine and thyroxine concentrations still higher. All these effects are given equally by the natural and synthetic paraxanthines.

It seems to us necessary to conclude from these results that the behaviour of the heart is determined not by the separate concentrations of thyroxine and paraxanthine in the medium but by the presence or absence of a definite *proportion* between their concentrations. When the concentrations are in this proportion—that of 1 mgm. thyroxine per l., and 0·22 µgm. paraxanthine per l.—the form of the curve is that of a winter heart. It remains so as long as the proportion between their concentrations is kept the same, even if the absolute concentrations of the two substances are changed greatly. On the other hand, when *either* thyroxine or paraxanthine are present in excess of these proportional concentrations, the form of the curve is that of a summer heart. We shall call concentrations in the proportion that gives the winter form of the curve 'balanced' concentrations.

Having obtained these results, we proceeded to examine the action of paraxanthine on the basal metabolic rate of the rat. The rats used were piebald males of the Wistar Institute strain, and the apparatus was that of Richards and Collison[5], which was found suitable for use with the rat by Gaddum[6].

When a rat is given small doses of paraxanthine daily by mouth, there is a fall of basal metabolic rate which becomes greater as the dose is increased to an optimum. For a rat of 200–250 gm. weight the optimum dose is 20–25 µgm. per day, and the basal metabolic rate with this dose is 70–75 per cent of the normal. If the dose is increased above this optimum, the basal metabolic rate rises again until with double the optimum dose it reaches the normal value. With still larger doses the effects are complicated and are still being investigated. It may, however, already be said that large overdoses (up to 1 mgm. per day to a rat) may be given without any large rise in the basal metabolic rate above the normal. Nor is the rat clearly unhealthy. These last results, whatever the reason may prove to be for the contrast between them and the results of adding excess thyroxine to the internal medium, explain why (if our results on the rat may be transposed to man) no marked effects on the basal metabolic rate have been observed when large doses of paraxanthine have been used in clinical practice.

We have estimated the paraxanthine content in the plasma of ox blood and find it to be about 0·2–0·6 µgm. per c.c. The total amount present in the blood of a rat (supposing it to have a similar content) would be 5–15 µgm. From this it appears that the natural concentrations of paraxanthine in the body are within the range in which changes in the concentration make large changes in the basal metabolic rate. An oral dose of 25 or 50 µgm. would make a large proportional change in the blood content.

Within this range it seems to us that our results on the frog's heart and on the basal metabolic rate of the rat are strictly parallel. Comparing the two sets of results, we must conclude that a low basal metabolic rate is characteristic of 'balanced' proportions between the concentrations of thyroxine and paraxanthine, for either thyroxine or paraxanthine given to a rat in this condition causes a rise of basal metabolic rate*. Excess paraxanthine, here as in the heart, has the same effect as excess thyroxine. Also, excess thyroxine can be neutralized by raising the paraxanthine concentration. This is shown by the results of some experiments in which rats were given thyroxine until their basal metabolic rates reached 200 per cent of the normal, and were then given paraxanthine while the dosage with thyroxine was continued. If the dose of paraxanthine was appropriate (about 100 μgm. daily for this basal metabolic rate), the basal metabolic rate fell, sometimes nearly to the normal level. Similarly, excess paraxanthine may be neutralized by thyroxine. If a rat has a normal basal metabolic rate as a result of being given excess paraxanthine, an appropriate dose of thyroxine causes a *fall* of the basal metabolic rate; thyroxine has the opposite of its usual effect. This was an especially striking result, since an action of thyroxine opposite to that which occurs in all normal circumstances has never, so far as we know, been observed.

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* The normal rat must always be on the thyroxine side of the balanced condition, since administration of paraxanthine to it always lowers the basal metabolic rate if the doses are small enough.

We think these results allow us to conclude that paraxanthine behaves as an antithyroid substance in the body under normal conditions, and that the control of the basal metabolic rate in the rat is by the presence or absence of certain 'balanced' proportions between the concentrations of paraxanthine and the thyroid secretion and not by the concentration of either independently. If the concentrations are balanced, the basal metabolic rate is low; excess of either substance raises the basal metabolic rate. We do not wish to suggest that in normal life changes in the paraxanthine content of the internal medium are used by the body to control the basal metabolic rate. We have no evidence at present whether the body has or has not any means of controlling the concentration of paraxanthine in the medium, as it has of controlling that of the thyroid secretion.

Work is being continued on these subjects, especially on the physiological activity of further purine derivatives akin to paraxanthine and on the distribution of paraxanthine in the body.

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May 20.

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[2] *Berichte*, **39**, 423 (1906).

[3] *Berichte*, **31**, 2622 (1898).

[4] *Z. Physiol. Chem.*, **24**, 376 (1898).

[5] *J. Physiol.*, **66**, 299 (1928).

[6] *J. Physiol.*, **68**, 383 (1930).

Liver Vacuoles and Anoxæmia

DURING an investigation, carried out on behalf of the Air Ministry in 1940, into the effects on animals of a sudden reduction in atmospheric pressure, one of our findings was the formation of large watery vacuoles in the cells of the liver. We have no access to the current German literature, and Dr. Ladewig's letter[1] was our first intimation that somewhat similar findings had been published in 1942 by Büchner and his colleagues and also by Hesse. We think, therefore, that we should briefly report our findings and compare them with those of the German workers in so far as these are given in Dr. Ladewig's epitome.

The vacuoles which we found in the cytoplasm of liver cells were 2–12 μ in diameter, most commonly about 7 μ. While some were perfectly spherical, many were slightly ovoid or polyhedral. The number in each cell varied from 1 to 12 and was most commonly 2–3. They were more commonly found adjacent to the nucleus than in the more peripheral cytoplasm. Some vacuoles were indented by the nucleus while others themselves indented the nucleus and distorted it to a crescentic shape. Their relative numbers varied a good deal in the different lobules, and in most, but not all, cases they were more numerous at the centre of the lobule. In paraffin and frozen sections they appeared as optically empty spaces containing neither fat nor glycogen. This description agrees with that given in Dr. Ladewig's epitome. We further showed that the vacuoles can be seen in living liver cells suspended in serum, and from their optical properties under these conditions we concluded that they were watery vacuoles, certainly neither gaseous nor lipoid.

The German workers found these vacuoles in airmen dying from the effects of high altitude, in animals exposed to an atmosphere of reduced oxygen content at normal pressure, and also in humans dying under conditions of acute anoxæmia (suffocation, drowning). They believed that in all cases the vacuoles were the result of anoxæmia.

In our experiments, vacuoles occurred in animals (rat, guinea pig, rabbit, monkey) which were explosively (that is, instantaneously) decompressed from a pressure of 1·0 to 0·016 atmosphere, in an atmosphere approximating to pure oxygen, the animals being kept at the low pressure for 2 hours before being sacrificed. A few of the animals died after 5–20 minutes exposure to the low pressure, and they, too, showed vacuoles. In these experiments we tried to prevent anoxæmia by passing oxygen through the chamber throughout the experiment, but we know from other evidence that the animals did suffer some degree of anoxæmia during their exposure to the low pressure. In these experiments, therefore, the vacuoles might have been due to anoxæmia, or to exposure to low pressure, or to the sudden reduction of pressure (decompression); though in the case of the animals dying after five minutes at low pressure the duration of the anoxæmia must have been very short.

We also found similar liver vacuoles in animals which were explosively decompressed from 6·0 to 1·0 atmospheres. In these experiments some of the animals died almost instantaneously as a result of the decompression, and vacuoles were found in them as well as in those which survived. In those animals which died instantaneously, both anoxæmia and exposure to low pressure seem to be excluded, and we reached the tentative conclusion that in all cases the vacuoles were the result of the sudden reduction of external pressure (decompression).

It seems likely, therefore, that these liver vacuoles can be produced by factors other than anoxæmia, and the contention that they afford a histological criterion for the occurrence of anoxæmia will require further investigation.

This work was part of a larger investigation carried out by I. de Burgh Daly, P. Eggleton, S. R. Elsden, C. O. Hebb and O. A. Trowell. As the histologist, I have in this instance acted as spokesman for the team.

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University of Edinburgh.

June 1.

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[1] Ladewig, P., NATURE, **151**, 558 (1943).

IBALD VON BESSER (1784–1842)

By VLADIMIR C. ASMOUS

an of the Arnold Arboretum, Harvard University

LLIBALD von BESSER belonged to that arge group of German botanists who spent of their lives in Russia and contributed very to the progress of botanical science in their d country. Some of them outrank von Besser importance of their achievement, but still owes a great debt to this indefatigable and entious botanist, the hundredth anniversary ose death occurred on October 11, 1942.

ibald Swibert Josef Gottlieb von Besser was on July 7, 1784, in Insbruck in the Tirol, his being a retired army officer. Both his parents when he was thirteen years old. A relative of his er, S. B. Schivereck, who was professor of y in the University of Lemberg, took the boy is family and helped him through *Gymnasium* he University. Schivereck was the man who ed the love of natural history in Besser and ted his first steps in field work. When Schivereck in 1806 he bequeathed his large herbarium to r, and this was a great help and inspiration for youth in his botanical studies. Besser studied in the University of Lemberg and graduated in icine from the University of Cracow in 1807, ost immediately taking a position of an assistant he Cracow Clinic.

lthough Besser was a skilful physician and prac- l medicine all his life, he did not enjoy medical k. At his first opportunity, in 1808, he accepted an r to become a teacher of zoology and botany in Volhynia *Gymnasium*. His schedule was heavy, t still he was able to find time to complete within years one of his most important works—his lora of Galicia”.

n August 1809 Besser was appointed a teacher of tural history in Krzemieniec *Gymnasium* (later a *cée*) and director of the botanic garden in that vn. This was the beginning of his long activity in ssia, to which country he devoted thirty-three ars of indefatigable work. He became one of the ost prominent specialists on the flora of south-estern Russia. He travelled extensively in Volhynia, odolia, Kiev and adjoining provinces and assembled very large herbarium, which he extended and nriched by exchanges with many other botanists. He was a successful teacher despite a minor defect of speech which made him a rather unattractive ecturer. Some of his students, especially A. L. Andrzejowski and Jundzill, later contributed much to his herbarium. He made the botanical garden in Krzemieniec one of the best in Russia, although he was always handicapped by a very meagre allowance for the upkeep of the institution.

In 1834 Besser was appointed professor of botany in the University of St. Vladimir in Kiev. He was the first professor to occupy that chair, and he had the difficult task of organizing the Botanical Department. Overwork impaired his formerly robust health, and he resigned in 1837 to return to his beloved Krzemieniec, where he lived and worked until his death on October 11, 1842.

Before his retirement Besser presented his extensive ntomological collections to the University of Kiev. e was an enthusiastic collector of insects from his hood until his death and the author of some works on entomology. His very large herbarium and excellent library of natural history books were sold by his widow to the University of Kiev.

Besser was an unusually hard-working, conscientious and painstaking botanist, who always chose the most difficult families and genera for study and clung tenaciously to each task until it was finished. He was considered one of the best experts of the classification of the genus Artemisia, to the elucidation of which he contributed greatly. In his private life he was a quiet, simple and good-natured man, very much liked by his numerous pupils and patients.

Besser's most important contributions to botanical literature are: “Primitiæ floræ Galiciæ”, 2 vols. (1809); “Enumeratio Plantarum hucusque in Volhynia, Podlia, Gub. Kiovensis, etc.” (1822); “Ueber die Flora des Baikals” (1834); eight monographs of the genus Artemisia and many other minor works, including some articles on entomology and medicine. Most of Besser's works are in Latin and German. Having been educated in Galicia, where a large proportion of the population are Poles, Besser spoke excellent Polish, but he did not master Russian so well. He lectured most of his life in Krzemieniec in Polish, but delivered his lectures in the University of Kiev in Latin.

Four different genera Bessera have been named in his honour, including Bessera Schult. f. (in Liliaceæ), which is a valid name.

PLYWOOD CONTAINERS

THE demand for various kinds of containers, hitherto made of metal, has increased enormously in India as a result of the War. With the increased demand, an acute shortage of metal sheeting has aggravated the position, so that manufacturers were finding it very difficult to dispatch their manufactures owing to the want of containers. The Forest Research Institute at Dehra Dun was in its infancy when war broke out in 1914, but by 1918 it had firmly established its position as an indispensable branch of the Indian Forest Department. It is fulfilling the same purpose in the present War. To assist in alleviating the shortage of containers, the Institute has been engaged in designing and testing many different types of containers made of ordinary commercial plywood. They range from small powder and pill boxes to large drums and barrels for oils, paints, greases, and dry goods. Indian Forest Leaflet No. 24, “Plywood Containers”, published by the Forest Research Institute (Dehra Dun, 1942), describes the investigations.

These plywood containers are easy to make and are durable. The chief qualities required are that the container should be strong enough to stand journeys by rail, road or sea and that it should hold its contents safely without leakage and without contamination and spoiling. Metal serves these purposes admirably and cheaply; but for certain types of drums, more especially the more expensive types which are made of galvanized or sheet iron, plywood is a good substitute and compares favourably in cost. The plywood drums are not difficult to make. They consist of a cylinder of plywood, with a top and bottom of thicker plywood (or solid wood) round which the cylinder is fixed. If extra strength is required, metal bands are added; and if required for liquids, they can be adequately coated internally to render them leak-proof. So far, plywood containers have been made at Dehra Dun for paints, oils, greases, dry goods, foodstuffs, medical stores and water. In addition, they have been kept filled with kerosene and petrol for several months without showing any signs of evaporation or leakage. A variety of inner coatings have been tested.

The leaflet is chiefly concerned with a description of the methods of manufacturing plywood drums, a detailed description with diagrams being given. The glue used for container work is a casein cement which can be prepared according to a formula of the Forest Products Laboratories, Madison, U.S.A.; this is recommended by the Dehra Dun Institute and is given in the leaflet.

Owing to the fact that the round containers take up much space in storage and transit, a rectangular plywood container has been designed by the Forest Research Institute. This is described in Leaflet No. 26, "Rectangular Plywood Containers" (Dehra Dun, 1942). The four sides are made of ordinary commercial 3-plywood. These are joined together by bent plywood corner pieces, rivets being used for fastening the corner pieces to the side sheets. Top and bottom are of 7-plywood and are fixed in the same way as the round wood container described in leaflet No. 24. Full details with diagrams are given.

SOME BRITISH EMPIRE TIMBERS

UNDER the auspices of the Department of Scientific and Industrial Research, the Forest Products Research Laboratory has issued a War Emergency Supplement to the "Handbook of Empire Timbers" published in 1939, edited by Mr. H. A. Cox (London: H.M. Stationery Office, 1943). In Part 1 some additional information on many of the timbers already dealt with is given, especially in connexion with insect attacks, though in the case of teak the data given have been known for many years.

In Part 2 sixteen species not previously described are dealt with under the heads of brief description of tree, its timber, seasoning properties, wood bending and mechanical properties, natural durability, insect attack, preservative treatment, working qualities, uses and supplies—the last-named a most important piece of information in the absence of which the rest has, from a commercial point of view, little more than an academic value. Some of the West African timbers in this list are of interest since the French were exporting them to Western Europe before the French Colonial Exposition held in Paris in 1931. The information given here on some of these species on this head is too qualified and guarded to be of much practical use.

The following hardwoods are dealt with: *Mitragyna stipulosa*, equatorial forests of Nigeria, Liberia, Ivory Coast, Cameroons and Gamboon, most frequently in association with *Sarcocephalus diderrichii*; *Piptadenia africana*, rain and mixed deciduous forests of Nigeria; also in Gold Coast, Ivory Coast, Cameroons, Belgian Congo and Angola; *Betula papyrifera*, moist slopes in eastern North America from the southern shores of Hudson's Bay to Labrador in the north to approximately 40° N. in the south; *Canarium schweinfurthii*, Sierra Leone to East Africa; *Celtis soyauxii*, West Africa, Central Africa,
Tanganyika and parts of Kenya; *Acer rub*
A. saccharinum (soft maples), eastern Can
rubrum extending to Newfoundland. *A. macro*
the Pacific maple; *Terminalia amazonia* (Na
Central American rain-forest region including
Honduras and Trinidad; purpleheart—
species of *Peltogyne*, Trinidad, British and
Guiana and Surinam—probably a wider dist
the limits of which are not definitely know
schmiedia tawa (Tawa), lowland and mountai
in North Island and to a very limited exte
northern part of South Island, New Zealand

The softwoods are limited to *Abies grand*
couver Island and on mainland opposite, ex
southward into the United States as far as Ca
Tsuga canadensis (eastern hemlock), lower
St. Lawrence and Nova Scotia, with muc
extended range in the United States; *Pin*
derosa, with its varieties extending from Cali
New Mexico and Western Texas in the so
southern British California in the north;
engelmannii from Alaska to New Mexico, at
its greatest size in British Columbia; *Larix*
(tamarack) and *Larix occidentalis* (western
upper basin of Columbian river in British C
stretching southwards into United States
as Oregon and Montana; *Podocarpus tota*
P. Lallii (totara), lowland and mountain
in North and South Islands of New Zealan
P. Lallii also in Stewart Island.

Some kiln schedules for a number of spec
given in a series of appendixes. It is emph
that these schedules are approximate on
represent conditions suitable for average q
of timber intended for normal use. It is adde
experience with timber from particular sou
supply destined for specific purposes will ge
enable modifications to be made.

COASTAL RADIO TELEPHON

IN an article with this title (*Bell Lab. Rec.*, 21,
March 1943), H. M. Pruden describes the p
status of the radio telephone service between
and vessels off the coast of the United Sta
within its harbours, which has undergone con
able growth and development during the past dec
The development work leading to the present
cessful system was begun more than twenty
ago, and as a result of this a complete coastal
system is now in use. It consists of fourteen
shore stations so located as to cover the entire
from Maine, through the Gulf of Mexico, and u
Pacific coast to Seattle.

Each of the shore stations includes a radio t
mitter, two or more radio receivers, and tern
equipment for associating each with the other
with their signalling and control circuits. Th
minal equipment is installed in the toll office.
the transmitter is installed in a small building er
for the purpose or in a telephone building or l
property. The receivers, however, are usually
some distance from the transmitters and are ger
mounted on poles. Since the transmitting
ment aboard ship is not so powerful as that
the shore receivers are spaced at shorter
than are the transmitters. In general, th rec

so placed that any ship that can be reached factorily by a shore station can in turn be picked tisfactorily by one of the receivers associated that shore transmitter.

nsmission from the shore station is at a fre- within the band 2,504–2,600 kc., while the -receivers operate at between 2,108 and 2,208 kc. all a shore station, the desired frequency is ed, the headset aboard ship is lifted, and the switch on the handle is pressed. This turns ship's transmitter, and the radiated carrier a carrier-operated relay in one or more of the receivers to operate and light a lamp in front operator.

methods are available for calling ships. The completely equipped vessels have a selective ding system. The operator dials the ship as he any shore subscriber, and a bell is rung aboard vessel called. For ships not equipped for dial ng, the operator transmits a 1,000-cycle tone the carrier from the shore transmitter, and then the ship by name or by its call letters. Such ls have a loudspeaker associated with their receiver, and the tone serves as an attention l. Besides completing calls between ship and , the terminal facilities also permit radio tele- conversations between ships through a shore n. The operating procedure is for the ship to shore and ask for a connexion to some other . The shore operator then calls this other ship, having reached it, plugs into a by-pass jack, h, through suitable contacts, rearranges the it. The output of the radio receiver is connected e input of the transmitter through a network, at speech is re-transmitted at a frequency that be detected by either vessel.

e of the innovations in the new terminal equip- t is the ability to make contact with the emer- y radio equipment of the telephone companies. emergency equipment is designed to take the e of wire facilities that are temporarily out of vice. The ability of the shore stations to com- icate with these emergency sets is very helpful mes in establishing the original connexion, since only one of the emergency sets is required, the e station taking the place of the other. A second rgency equipment is put into use as soon as sible, however, and the operating frequency nged, so as not to tie up harbour equipment. shore station radiates carrier continuously while ndling calls with vessels, while for the emergency uipment the carrier must be under voice control. make this possible, the technical operator is pro- ded with a key that rearranges the circuit. The tching relay operates under control of the in- ning carrier, to connect the shore circuit to the io receiver. Under these conditions, there is no ed input to the vogad and hence none to the plifier-detector. As a result there is no current ough the winding of the voice-holdover relay, and circuit through its back contact disables the radio nsmitter. When incoming speech ceases, the tching relay is released, thus connecting the shore uit to the transmitter. Voice signals from the shore circuit result in a current in the output of the amplifier-detector that operates the voice-holdover relay, and causes the transmitter to radiate carrier. same current also operates the echo-holdover thus opening the circuit to the switching relay incoming speech cannot interfere with out- g nals.

CLIMATE AND ANIMAL DISEASE IN INDIA

IN his presidential address read before the Section of Medical and Veterinary Sciences of the thirtieth Indian Science Congress held at Calcutta last January, Dr. F. C. Minett, director of the Imperial Veterinary Research Institute, Muktesar, United Provinces, discussed the influence of climate on the incidence of disease.

At the outset, Dr. Minett emphasized the value of the association of medical men and veterinarians in research, as is exemplified in the Indian Science Congress and in the Section of Comparative Medicine of the Royal Society of Medicine. While admitting that veterinary science has gained more than it has given by contact with medicine, he dwelt on the enormous extent to which medical science has had to rely upon experiments on animals in connexion with elucidation and prevention. As regards the effect of climate and weather conditions on animal health and disease, Dr. Minett mentioned the influence of air temperature and humidity on the spread of such diseases as filariasis, malaria and plague. On the other hand, climate may not be the only environmental factor at work; other complex influences, such as naturally acquired immunity and conditions of crowding, may be still more important. Climatic factors might be neutralized by the occurrence of improved facilities for disinfection, as in the case of cholera. As the relation between weather effects and disease in man cannot always be determined by statistics, experiments on animals are needed, with results which may or may not confirm previous deductions.

Although a good deal is known of the effect of environmental factors, including climate, on human beings and small experimental animals, comparatively little is known with regard to domesticated animals like sheep and goats. In order to obtain more exact information, figures are being collected through provincial directors of veterinary services relating to the prevention of animal diseases during the monsoon period, just as has been done on the medical side with cholera, typhoid, etc. As regards the monsoon prevalence of disease, wet conditions are a sore trial to many animals in some tropical countries, even to such water-loving animals as buffaloes. The effect of rainfall on animals has recently been studied by artificial showers. Sheep inoculated intramuscularly with very small doses of spores of *Cl. chauvoei*, the causal agent of blackwater in cattle and sheep, showed symptoms of the disease and died after exposure to a shower, while control sheep remained healthy. On the other hand, guinea pigs injected with the spores and then treated in an incubator at 40° C. are more likely to escape the disease than controls. A similar effect has been produced in the case of anthrax.

Dr. Minett next dealt with the deterioration or degeneration of cattle, which it is hoped will be investigated by the Imperial Council of Agricultural Research. Whether the deterioration is solely or mainly due to climate is not yet known; but if it is, it will have to be determined whether climate is exerting a direct effect on the animal physiology, or whether the effect is indirect and is more properly to be attributed to a hot atmosphere.

In conclusion, Dr. Minett referred to the control of disease in India, which is hindered by religious prejudices whereby the survival of useless animals and active dissemination of disease are permitted. Further, there is the undeveloped legislation for controlling animal diseases and the extensive movements of cattle, sheep and goats which are made annually for food to escape the monsoon. In spite, however, of shortage of staff and difficulties of communication, Dr. Minett considers that much success has been obtained both in the laboratory and in the field.

FORTHCOMING EVENTS

Tuesday, June 29

Free German Institute of Science and Learning (at 16 Buckland Crescent, London, N.W.3), at 8 p.m.—Mr. J. A. Lauwerys: "Education in the U.S.A.".

Friday, July 2

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. O. T. Jones, F.R.S.: "The Yellowstone National Park, U.S.A.".

Saturday, July 3

Nutrition Society (joint meeting with the Food Group of the Society of Chemical Industry) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "Milk" (Chairman: Prof. H. D. Kay).

London Mathematical Society (joint meeting with the London Branch of the Institute of Physics) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2 p.m.—Dr. A. C. Aitken, F.R.S.: "Matrices in Practical Mathematics"; Dr. L. J. Comrie: "Computational Methods and Mathematical Tables"; Mr. H. L. Blackburne: "Mathematical Solutions by Models"; Dr. S. Whitehead: "Applications of Elementary Mathematical Processes, with special reference to Circuit Theory".

Saturday, July 3—Sunday, July 4

Town and Country Planning Association (at the Waldorf Hotel, Aldwych, London, W.C.2), at 10.30 a.m.—Conference on "Town Planning, Housing and Full Employment".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Master, able to offer Technical Drawing and/or Engineering Science and/or Practical Mathematics—The Headmaster, Millom Junior Technical School, Millom, Cumberland (July 3).

Head of the Mathematics and Physics Department in the Rutherford Technical College—The Director of Education, Education Committee, Newcastle-upon-Tyne (July 3).

Principal of the Barnsley Mining and Technical College—The Director of Education, Education Department, Town Hall, Barnsley (July 7).

Professor and Head of the Department of Electrical Technology, and a Professor and Head of the Department of Applied Mechanics and Automobile Engineering—The Registrar, Indian Institute of Science, Bangalore, India (September 15).

Assistant Lecturer in Botany—The Principal, Swanley Horticultural College for Women, Swanley, Kent.

Agricultural Organizer to the National Federation of Women's Institutes—The General Secretary, 39 Eccleston Street, London, S.W.1.

Lecturer in Engineering, for Achimota College, Gold Coast—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1737), Alexandra House, Kingsway, London, W.C.2.

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